AMALGAMATED N P S FERTILIZER ON CROP PERFORMANCE AND NODULATION OF SOYBEAN VARIETIES ON ACIDIC SOIL.

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ABSTRACT

This experiment was aimed to evaluate the effect of amalgamated NPS chemical fertilizer on crop performance and nodulation of soybean (*Glycine max* L (Merrill)) varieties on acidic soil during 2020 cropping season. Varieties of soybean i.e "Katta" and "Korme" and six levels of amalgamated NPS chemical fertilizer were used in factorial arrangement within randomized complete block design with three replications. Nodule parameters were highly influenced (P<.001) by the main effect of amalgamated NPS chemical fertilizer levels. The highest grain yield (2390 kg ha^{-1}) was obtained from application of 19(N) 38(P_2O) 7(S), kg ha^{-1} .. "Katta"and "Korme" varieties of soybean were high yielder at level of 19(N) 38(P_2O) 7(S), kg ha^{-1} combined NPS fertilizer application. Therefore, both varieties "Katta" and "Korme" with application of 19(N) 38(P_2O) 7(S), kg ha^{-1} mixed chemical fertilizer were recommended for enhancing nodule development and seeds yield.

Key words: Amalgamated NPS, Katta and Korme,soybean, nodule, seeds yield

محفز سماد *NPS* على أداء محصول فول الصويا وتقييم الاصناف في التربة الحامضية.

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1 باكو الزراعية. التعليم والتدريب التقني والمهني. ولاية أوروميا الإقليمية ، باكو ، إثيوبيا
2 محمية نبات أمبو. ريس. المركز ، معهد إثيوبيا للزراعة. ريس. (EIAR) ، أديس أبا ، أ
3 قسم علوم النبات بالكلية الزراعية. جامعةووليجا ، حرم شامبو ، إثيوبيا

المستخلص

هدفت هذه التجربة إلى تقييم تأثير السماد الكيميائي NPS المندمج على أداء المحصول وتعقيد أصناف فول الصويا (Glycine max L (Merril) في التربة الحامضية خلال موسم المحاصيل 2020. تم استخدام أنواع مختلفة من فول الصويا مثل "كاتا" و "كورمي" وستة مستويات من السماد الكيميائي NPS المندمج في ترتيب عاملي ضمن تصميم القطاعات العشوائية الكاملة بثلاثة مكررات. تأثرت معاملات العقيدات بشدة (P >.001) بالتأثير الرئيسي لمستويات السماد الكيميائي NPS المندمجة. تم الحصول على أعلى إنتاجية للحبوب (2390 كجم هكتار -1) من استخدام 19 (S) 7 (P2O) 38 (N) ، كجم هكتار -1. من 19 (S) 7 (P2O) 38 (N) ، كجم هكتار -1 تطبيق السماد NPS المشترك. لذلك ، تم التوصية باستخدام كلا الصنفين "كاتا" و "كورمي" باستخدام 19 (S) 7 (P2O) 38 (N) ، كجم هكتار -1 من السماد الكيميائي المختلط لتعزيز نمو العقيدات وإنتاج البذور.

الكلمات المفتاحية: الحامضية مدمجة NPS ، كاتا وكورم ، فول الصويا ، عقيدات ، محصول البذور

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INTRODUCTION

In Ethiopia, soybean is cultivated over wider range of agro-ecologies particularly in low to mid altitude areas. However, the world average yield of soybean is 2.6 t ha^{-1} which is higher than national average yield of Ethiopia which is 2.1 t ha^{-1} (8). The national average productivity of soybean speckled from 1.8 t ha^{-1} to 2 t ha^{-1} while the potential yield at research and farmers' field are 3.5 and 2.6 t ha^{-1}, respectively (13). The major bottlenecks for low yield of soybean were poor crop husbandry, low soil fertility, lack of varieties which resistance diseases and insect pests, low rate acceptance of soybean production technologies, accessibility of improved varieties, weed and biotic factors (long dry spell period and drought) (16). In spite, of this many biotic factors and abiotic factor contribute to the low yield (2, 14). Among thus nitrogen, phosphorus and sulfur are the main factors that significantly reduce the production and productivity of legume crops (3, 4, 23). Soil acidity associated soil fertility problem is one of the most important soybean production constraints in several countries like in Western Ethiopia (26). Most of Ethiopia soils have deficiency of N, P, K, S, Zn, B and Cu. Thus, suggests that use of modified and well balanced fertilizer is important for increasing the productivity of soybean (12). This emphasizes the importance of developing an alternative means to meet the demand of nutrient in plants by using of mixing NPS fertilizer that contains S in addition to the commonly used N and P fertilizers. Gobu Sayo is a mid-altitude areas which is suitable for soybean cultivation in East Wollega Zone of Western Ethiopia. Even though, the study area is suitable for soybean production the farmers do not adopt the recommended soybean production technologies like the use of improved varieties and application of blending NPS fertilizer. However, farmers in the study area have been using uniform blanket application of 100 kg DAP ha^{-1} for all pulses including soybean to proliferation crop yields without considering soil fertility status and crop nutrient requirement (9). There is limited information on selection of improved soybean varieties and optimum recommended blended NPS fertilizer rates and economical feasible of soybean production in Gobu Sayo district of Western Ethiopia. Therefore, this research can solve the problem of lower yielding of soybean productivities and economically feasible blended NPS fertilizer rate in Western Ethiopia, particularly at Gobu Sayo district by using Katta or Korme variety which is superior and stable in seed yield, quality traits and resistant to bacterial blight and bacterial pustule compare to commercial variety . Hence, the investigation was stressed on the following objectives: to evaluate the effect of amalgamated NPS chemical fertilizer on crop performance and nodulation of soybean (*Glycine max* L (Merrill) varieties

MATERIALS AND METHODS

Description of the study site The field experiment was conducted at Bako Agricultural Research Center, in Gobu Sayo district in Oromia National Regional State. The site is situated at 09°06' N latitude and 7°09' E longitude with altitude of 1650 masl. The total rainfall in the cropping season was 1261.7mm, the mean minimum and maximum temperatures were 14.8^0C and 29.8^0Crespectively (5).

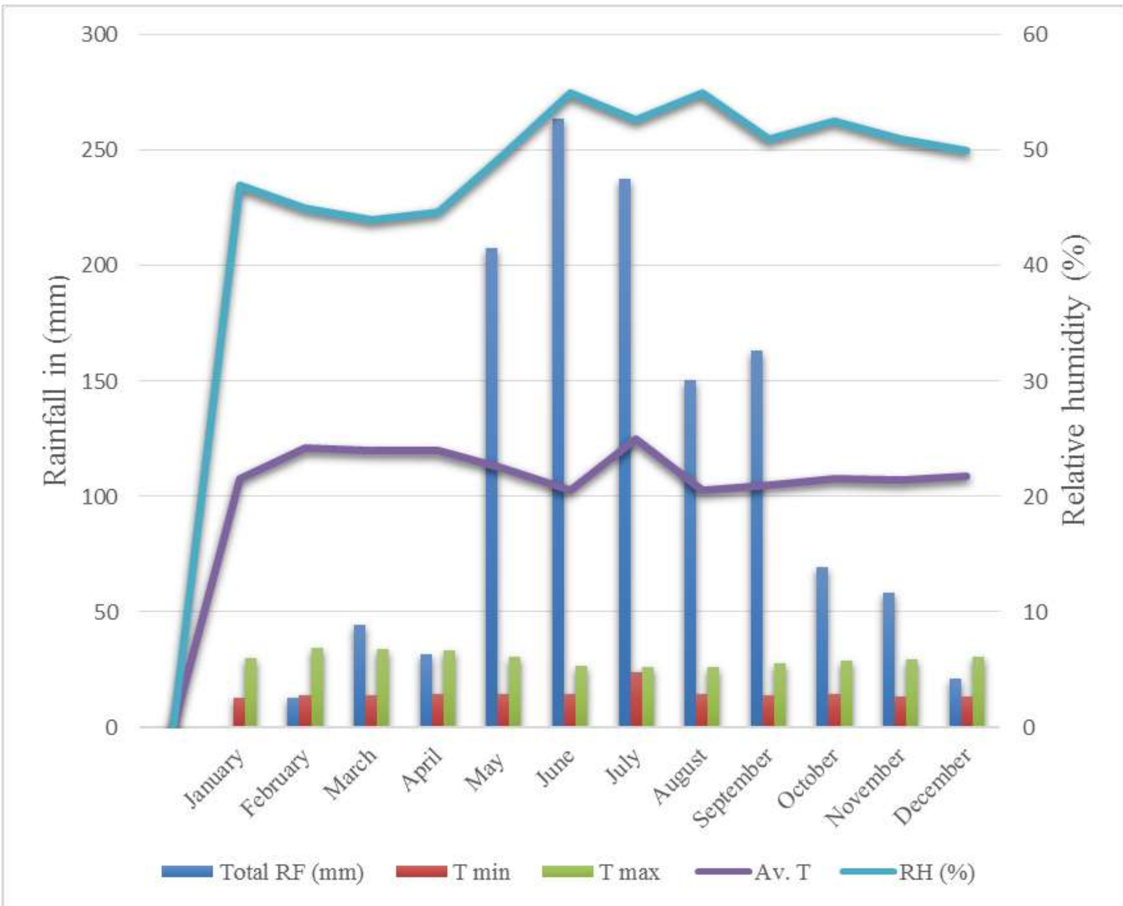

Figure 1. Agrometeorological data of the study areas

The monthly meteorological data (relative humidity, rainfall, maximum temperature, minimum temperature and average temperature) of growing period of 2020 at experimental site were illustrated in (Figure 1).

Treatments and experimental design

The treatments contained two levels of soybean varieties (Katta and Korme) and six level of combined NPS chemical fertilizer i.e unfertilized plot, 9.5(N) 19(P_2O) 3.5(S), 14.25(N) 28.5(P_2O) 5.25(S), 19(N) 38(P_2O) 7(S), 23.75(N) 47.5(P_2O) 8.75(S) and 28.5(N) 57(P_2O) 10.5(S) kg ha^{-1}. The treatments were arranged in factorial layout within randomized complete block design (RCBD) with three replications. The gross plot area was 3.0 m × 2.4 m = 7.2m^2. The spacing between blocks and plots were 1.0 m and 0.5 m, respectively. Each plot has been 6 rows spaced 40 cm apart and each row has been 30 plants spaced 10 cm apart. One outer row from both side of the plot and two plants from each end of rows were considered as border. The 4 middle rows were used as net plot which is harvestable. The net plot size was 2.6m x1.6m =4.16m^2. Soybean varieties Katta (PR-145-2) and Korme (AGS-129-2) developed and released in 2011 by Bako Agricultural Research Center were used as planting material

Data collection and measurements

An initial soil samples were collected from the entire experimental field to a depth 0-20cm in a diagonally using soil auger after ploughing. Then the collected soil sample was air dried by spreading on plastic sheet at room temperature. The dried soil sample was ground with mortar and pestle to pass through a 2mm sieve and the composited soil samples were analyzed for selected physicochemical properties mainly on textural analysis, soil pH, total N, P, K, OC and cation exchange capacity (CEC) (cmol kg^{-1}) using the appropriate laboratory procedures.

Phenological traits

Days to 75% emergence, days to 75% flowering and days to 90% maturity were recorded.

Nodulation parameters

The total number of nodules: Determined by counting nodules from five plants randomly taken from harvestable rows of each plot at flowering time. Effective and non-effective nodules: They were separated by their colors where a cross section of an effective nodule made with a pocket knife showed a pink to dark-red color, whereas a green and white color indicates non-effective nodulation. Volume of the nodules: the effective nodules of the above five plants of each plot were collected carefully and immersed in a 50mL capacity plastic cylinder which was filled up to 30mL with water The volume of water displaced by the nodules obtained from the five plants was recorded and the average was considered as nodule volume per plant (24).

Nodule dry weight: the nodules collected from the five plants were recorded by putting in the oven dry in 80^0C for 24 hours and weighed in g $plot^{-1}$.

Growth traits

Number of leaves per plant: Determined by counting number of leaves per plant from five plants randomly taken from each plot at flowering time.

Number of primary branches per plant: Determined by counting number of branches per plant from five plants randomly taken from each plot at physiological maturity.

Plant height: Measured at the plant is physiologically matured randomly from five plants per plot just from the ground level (from the soil surface) to the apex of the plant

Yield and yield components

Number of pods per plant: Determined by counting the number of pods per plant from five randomly selected plants from each plot at harvest.

Pod length: Determined by measuring length of pod from five randomly selected pods from each plant at harvest and the average was taken as length of pods per plant.

Number of seeds per pod: The total number of seeds in five randomly taken pods from each plant was counted and divided by number of pods to find the number of seeds per pod.

Number of seeds per plant: Calculated by multiplying number of pods per plant with seeds per pod from each plant and averagely putted as number of seeds per plant for each plot at harvest.

Thousand seed weight: Determined by taking a weight of 1000 grains from seed of each plot and weighed using a sensitive balance at designated moisture content of 10.5%.

Dry biomass yield: Taken after harvesting from the whole plant parts, including leaves, stems, and seeds from the net plot. Then sun dried up to lose the moisture content for one week in open air and weighted and converted into kg ha^{-1}.

Seeds yield: Recorded from net plot area of each plot after sun drying and this yield was adjusted to moisture level of 10.5%. Finally, yield per plot was converted to per hectare and the average yield was reported in kg ha^{-1}.

Harvest index: Calculated by dividing grain yield per net plot area by the total above ground dry biomass yield per net plot area and was multiplied by 100.It is a the ratio of seed yield (kg ha^{-1}) to dry biomass yield (kg ha^{-1}) *100

Data analysis

Analysis of variance and correction among the treatment were carried out using PROC GLM and PROC CORR procedure of SAS software respectively

RESULTS AND DISCUSSION

Soil physio chemical properties of the study site: Selected physio chemical properties soil of the experimental site is presented in Table 1. The site has clay textural class with a particle distribution of 49% clay, 9% silt and 42% sand. Soil pH (H_2O) was 5.16 which is under strong acidic (4.5-5.5) (15).This show that essential plant nutrients are fixed in soil colloidal practices and nutrient was unavailable to plant growth. The organic carbon (OC) content was 2.61 % which was moderate. The soil of the study area had low level (0.19 %) optimum nitrogen medium level (2.61 %) of organic carbon matter.

Table 1. Physical-chemical properties of the experimental site soil before planting

Characters	Value	Rating
A. Soil texture		
Sand (%)	42	
Silt (%)	9	
Clay (%)	49	High
Textural Class		Clay
B. Chemical analysis		
Soil pH	5.16	Strong acidic
Organic carbon (%)	2.61	High
Organic Matter	4.5	Moderate
Total N (%)	0.19	Optimum
Available P (mg kg^{-1})	6.96	Very low
CEC (meq/100g soil)	15.8	Medium
Ex.Ca(cmol/kgsoil)	6	Medium
Ex.Mg(cmol/kgsoil)	4	High

Crop phenology

Days to emergence: Days to emergence were not influenced by the main effect of varieties, combined NPS chemical fertilizer levels and their interactions (Table 2). This might be due to optimum moisture content during sowing time and the physiological germination of soybean influenced by soil temperature, moisture availability and land preparation.

Days to flowering: Application of combined NPS chemical fertilizer levels were highly significant (P<.001). But, the main effect varieties and the interaction effect of varieties and combined NPS chemical fertilizer were resulted insignificant differences on days to flowering. It extended from 60.67 to 67.5 days (Table 3) where the longest days 67.5 was observed at plot receive the application of 28.5(N) 57(P_2O) 10.5(S) kg ha^{-1} and the shortest days (60.67) was attained at nil application. Days to flowering shows increasing fashion with increasing from nil application to 28.5(N) 57(P_2O) 10.5(S) kg ha^{-1}. The results agreed with Habtamu et.al (13) who reported that the application of N delayed days to flowering of soybean. According to Shumi et.al (21), Tarekegn and Kibret (25) the days to flowering of common bean prolonged by application of P fertilizer. This might be due to fact that the increasing combined NPS fertilizer level give more luxurious time for vegetative growth which delay the days to flowering.

Days to physiological maturity: Days to physiological maturity was highly significant (P<.001) influenced by the main effect of combined NPS chemical fertilizer levels. However; the main effect varieties and the interaction effect of varieties and combined NPS fertilizers were resulted insignificant differences on days to physiological maturity (Table 2). The longest days were identified at 28.5(N) 57(P_2O) 10.5(S) kg ha^{-1} but statistically at par with 23.75(N) 47.5(P_2O) 8.75(S kg ha^{-1} and 19(N) 38(P_2O) 7(S) kg ha^{-1}. Shortest days to physiological maturity was discovered at unfertilized plot but at par with 9.5(N) 19(P_2O) 3.5(S) kg ha^{-1} and 14.25(N) 28.5(P_2O) 5.25(S) kg ha^{-1} (Table 3). This might be because of nitrogen and phosphorus obtained from NPS fertilizer enhances vegetative growth and delayed physiological maturity of soybean.

Table 2.Mean square analysis of Use of Combined NPS Chemical Fertilizer on Crop Performance and Nodulation of Soybean (Glycine max L. (Merrill) Varieties

Plant parameters	Replication (2)	NPS (5)	Varieties (1)	NPS * Varieties (5)	Residual (22)	CV (%)
Days to emergence	1.0	0.80	0.00	0.20	0.3636	8.8
Days to flowering	2.2500	19.53**	1.7778	1.71	0.6136	1.2
Days to maturity	7.528	22.161**	0.028	0.428	2.497	1.2
Total nodules per plant	35.81	116.54**	0.40	0.48	14.53	23.7
Effective Nodules per Plant	29.03	105.27**	0.04	0.78	14.24	24.3
Nodules volume per plant	0.5713	0.5539**	0.1344	0.0106	0.1068	26.4
Nodules weight per plant (gm)	0.001467	0.013330**	0.001600	0.000413	0.001430	24.2
Plant height (cm)	13.443	2350.714**	1.210	2.426	4.672	3
Number of primary branches per plant	1.1911	2.1264*	0.1344	0.0784	0.5560	11.2
Number of leaves per plant	206.3	2566.3**	10.0	51.6	114.0	10.0
Number of pods per Plant	60.35	380.15**	0.75	9.32	73.71	14.7
Pod length (cm)	0.02812	0.06587**	0.03145	0.01388	0.01563	3.2
Number of Seeds per Pod	0.01560	0.03349	0.04000	0.00843	0.02113	5.3
Number of Seeds per Plant	381.7	6063.5**	2.2	139.5	547.7	15.0
Thousand seed weight (gm)	135.19	263.64*	413.44*	72.51	76.10	5.5
Grain yield (kg ha^{-1})	2315	591871**	9483	36828	31146	9.0
Above ground dry biomass (Kg ha^{-1})	612406	3471356**	48136	42862	447060	12.1
Harvest index	30.50	30.18	5.68	5.88	11.43	9.5

The number in the parentheses indicate the degrees of freedom ** highly significant (p<0.01), *Significant (P < 0.05), CV (%); Coefficient of variation in percent

Table 3. The main effect of soybean varieties and combined NPS chemical fertilizer levels on the phenological parameters of soybean

Treatment	Days to emergence	Days to flowering	Days to physiological maturity
Unfertilized plot,	6.33	60.67e	124.7 c
9.5(N) 19(P_2O) 3.5(S)	6.50	62d	125.0 c
14.25(N) 28.5(P_2O) 5.25(S)	6.83	62.33d	126.3bc
19(N) 38(P_2O) 7(S)	7.00	63.67c	128.2 ab
23.75(N) 47.5(P_2O) 8.75(S)	7.00	65b	128.3 a
28.5(N) 57(P_2O) 10.5(S)	7.33	67.5a	129.3 a
Mean	6.83	63.53	127
LSD (5%)	NS	1.12	1.892
Varieties			
Korme	6.83	62.33	126.94
Katta	6.83	62.67	127.00
Mean	6.83	62.5	127
LSD (5%)	NS	NS	NS
CV (%)	8.8		1.2

Means in the same column and treatment category followed by the same letters are not significantly different as judged by LSD at 5% level of significance

Nodulation traits

Total nodules per plant: The result revealed that total nodules per plant was highly influenced (P<.001) by the main effect of combined NPS chemical fertilizer levels. However; the main effect varieties and the interaction effect of varieties with combined NPS chemical fertilizer were resulted insignificant differences on total nodules per plant (Table 2). Total nodules per plant showing an increasing fashion as the rate of NPS fertilizer increases from the level of unfertilized plot to 28.5 (N) 57(P_2O) 10.5 (S) kg ha^{-1} (Figure 2). Thus, the highest number of nodules per plant (21.20) was obtained from the application of 28.5 (N) 57(P_2O) 10.5 (S) kg ha^{-1} and it was statistically at par with 23.75(N) 47.5(P_2O) 8.75(S) and 19(N) 38(P_2O) 7(S) kg ha^{-1} while the lowest number of nodules per plant (12.21) was recorded for unfertilized plot (Table 4). This might be because better root development with increasing levels of combined NPS fertilizer can increase numbers of nodules per plant. In addition the amount of P fertilizer in the NPS relatively large amounts which is needed by legumes for growth and to promote leaf area, biomass, yield, nodule number and nodule mass. The results agreed with Deresa (10) and Bekere et al. (7) they reported that total number nodule per plant were increasing as the rate of NPS blended increases from 0 to 200 kg NPS ha^{-1}. Maximum of number nodule plant were recorded from cluster bean by application of P and S nutrient fertilizer (27).

Table 4. The main effect of soybean varieties and combined NPS chemical fertilizer levels on the nodulation parameters of soybean

Treatment	Total number of nodules $plant^{-1}$	Effective Nodules $plant^{-1}$	Nodules volume (ml $plant^{-1}$)	Nodule dry weight (g $plant^{-1}$)
Combined NPS Fertilizer(Kg ha^{-1})				
Unfertilized plot,	9.17d	8.70d	0.733c	0.0847c
9.5(N) 19(P_2O) 3.5(S)	13.73c	13.47c	1.100bc	0.1227bc
14.25(N) 28.5(P_2O) 5.25(S)	14.77bc	14.53bc	1.175ab	0.1550b
19(N) 38(P_2O) 7(S)	19.17ab	18.53ab	1.483ab	0.2050a
23.75(N) 47.5(P_2O) 8.75(S)	18.60ab	17.90abc	1.383ab	0.1663ab
28.5(N) 57(P_2O) 10.5(S)	21.20a	20.13a	1.558a	0.2050a
Mean	16	15	1.2	0.16
LSD (5%)	4.564	4.518	0.3914	0.04528
Varieties				
Korme	16.00	15.58	1.178	0.1498
Katta	16.21	15.51	1.300	0.1631
Mean	16	15	1.24	0.16
LSD (5%)	NS	NS	NS	NS
CV (%)	23.7	24.3	26.4	24.2

Means in the same column and treatment category followed by the same letters are not significantly different at 5% level of significance

Effective modules per plant: Effective nodules per plant was highly influenced (P<.001) by the main effect of combined NPS fertilizer levels. However, the main effect varieties and the interaction effect of varieties with combined NPS chemical fertilizer levels were resulted insignificant differences on effective nodules per plant (Table 2). The increasing of NPS fertilizer rate from unfertilized plot to 28.5 (N) 57(P_2O) 10.5 (S) kg ha^{-1} enhanced the number of effective nodules per plant (Figure 2).

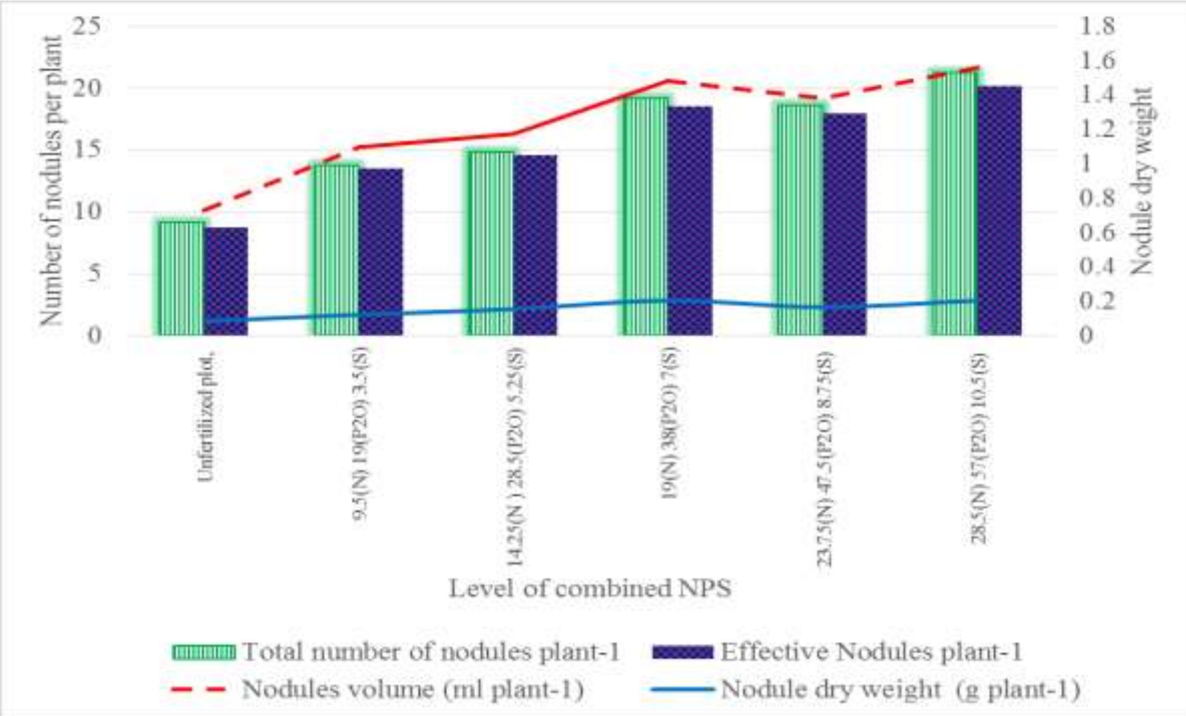

Figure 2. The effect of combined NPS chemical fertilizer levels on nodulation parameters of soybean

This might be because the increased number of effective nodules with the increasing in NPS nutrient application up to 28.5(N) 57(P_2O) 10.5(S) kg ha^{-1} might be due to the vital role of phosphorus available in NPS and have an essential ingredient for N-fixing bacteria to increase the number of effective nodules and size of nodule and the amount of nitrogen assimilated per unit of nodules. The results agreed Begum et.al (6) who reported that application of S fertilier increases the number effective nodules $plant^{-1}$ at all the growth stages of soybean. Similarly, Scherer et.al (22) who reported that effective nodule per plant of black gram were increases as the application level of S fertilizer increases which is involved in the formation of nitrogenous enzyme known to promote nitrogen fixation in legumes.

Nodules volume per plant: The analysis of variance (ANOVA) show that nodules volume per plant was highly influenced (P<.001) by the main effect of blended NPS fertilizer levels. However; the main effect varieties and the interaction effect of varieties and combined NPS fertilizer were resulted insignificant differences on effective nodules per plant (Table 2). The result agreed Bekere (7) who described the three phosphorus levels (60, 120 and 180 mg P kg^{-1}) resulted in significantly (P< 0.05) higher nodule volume per plant than the unfertilized control

Nodules weight per plant (g): The main effect of varieties and interaction of NPS fertilizer rate with varieties were non-significant effect on nodule dry weight (Table 2) while the main effect of NPS application rate was highly significant (P<0.01) on nodule dry weight per plant (Table 4, Figure 2). This might be because phosphorus and Sulphur increase the weight of nodule content. P application on legumes crop increases the nodule weight and enhancing the rate of reduction of acetylene of the nodules (28). Katta and Korme were have similar nodulations physiology. However, the Katta variety more responsive for nodulations parameters (Figure 3).

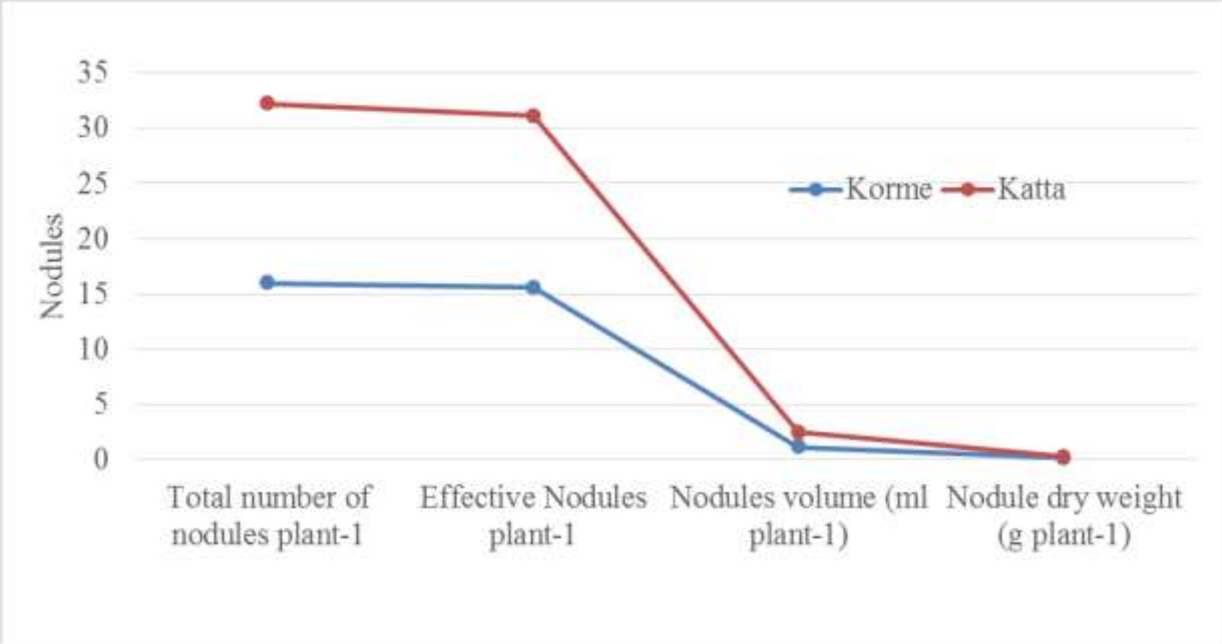

Figure 3. Response of variety for nodulation parameters

Crop growth traits

The result were showed that plant height, leaves number per plant, number of primary branches were significantly (P<0.001) influenced by main effect of blended NPS fertilizer rate. All growth parameter were not influenced by varieties and interaction of varieties with combined NPS chemical fertilizer levels (Table 5). The results in agreement with Shumi et al. (21) who reported increasing rates of P levels in blended NPS fertilizer from 0 to 150 kg NPS ha^{-1} showed progressive increases in plant height of common bean. According to Akter et al. (1) ,plant height increased with increasing levels of Sulphur application up to 40 kg S ha^{-1}.

Table 5. The main effect of soybean varieties and blended NPS fertilizer rate on the nodulation parameter of soybean

Treatment	Plant height (cm)	Number of leaves per plant	Number of primary branches per plant
Unfertilized plot,	42.83^{e}	70.7^{d}	5.73 ^{c}
9.5(N) 19(P_2O) 3.5(S)	55.23^{d}	94.9^{c}	6.233^{bc}
14.25(N) 28.5(P_2O) 5.25(S)	65.60^{c}	111.4^{b}	6.800^{ab}
19(N) 38(P_2O) 7(S)	86.23^{b}	126.5^{a}	6.800^{ab}
23.75(N) 47.5(P^2O) 8.75(S)	88.30^{ab}	114.7^{ab}	7.367^{a}
28.5(N) 57(P_2O) 10.5(S)	89.90^{a}	121.7^{ab}	7.100^{ab}
Mean	71.3	107	7
LSD (5%)	2.588	12.78	0.893
Varieties			
Korme	71.53	106.1	6.73
Katta	71.17	107.2	6.61
Mean	71.35	107	7
LSD (5%)	NS	NS	NS
CV (%)	3.0	10.0	11.2

Means in the same column and treatment category followed by the same letters are not significantly different at 5% level of significance

Begum et al. (6) were repoted crop grown with 40 kg N ha^{-1} produced the tallest plant while with 0 kg N ha^{-1} treatment produced the shortest plants height. The increment in primary branches $plant^{-1}$of soybean might be due to favorable effects of phosphorus and Sulphur on hormonal balance that helped proper growth and development of the soybean plant. This is in line with those Shengu and Ademe (20) and Akter et al. (1) who reported the P and S fertilizer application had a significant impact on the number of primary branches $plant^{-1}$ of soybean.

Yield and yield components

The analysis of variance showed that all yield and yield components of soybean were highly influenced (P<0.001) by the combined NPS fertilize rate (Table 6). The highest seeds yield (2390 kg ha^{-1}) were recorded due to the application of 19(N) 38(P_2O) 7(S) kg ha^{-1} amalgamated NPS fertilizer application rate while the lowest 1500 kg ha^{-1} seeds yield was gained from unfertilized plot (Figure 4). Whereas, the interaction effect and the main effect of varieties were non-significant with the exception of thousand seeds weight. Similarly, Akter et al. (1) who reported the combined effect of different doses of P and S fertilizers on the number of pods $plant^{-1}$ was significant. Inaddition, Gabisa et al. (12) who reported significant variation in number of pods $plant^{-1}$ was observed at various levels of phosphorus application. Shumi et al. (21) who reported that the main effect of P rate in blended NPS was significant on plant height, number of total pods per plant, days to flowering, days to maturity, hundred seeds weight, number of primary branches per plant and seeds yield of common bean. This result was agreed with Nasren and Farid (18) who recorded highest number of pods per plant with 60 kg S ha^{-1} followed by 40 kg S ha^{-1} in soybean. Begum et al. (6) reported nitrogen had significant effect on yield and yield contributing characters of soybean. The result was collaborated with Habtamu et al. (13). The result was confirming with Dame and Tasisa (9) who reported that soybean seeds yield consistently increased with increase in the rate of applied N to the optimum level of N and the grain yield recorded due to each successive rate of N were different from each other. The result was confirming with Shumi et al. (21) who observed that the highest seeds yield was recorded from the highest rate of Phosphorus application up to 150 kg NPS ha^{-1}, while the lowest yield was observed for nil application of P fertilizer. Similarly, Nebret (19) reported that application of phosphorus influences the seed yield of French bean significantly up to 60 kg P_2O_5 ha^{-1} Likewise, Akter et al. (1) who reported the combined application of P and S further enhanced seed yield of soybean and the highest seeds yield of soybean was recorded in the treatment combination (30 kg P ha^{-1}+20 kg S ha^{-1}). Also, Majumdar et al. (16) reported the highest seed yield of soybean was recorded with the application of Sulphur up to 30 kg ha^{-1} and being on par with 40 kg S ha^{-1} was significantly superior to rest of the levels of Sulphur.

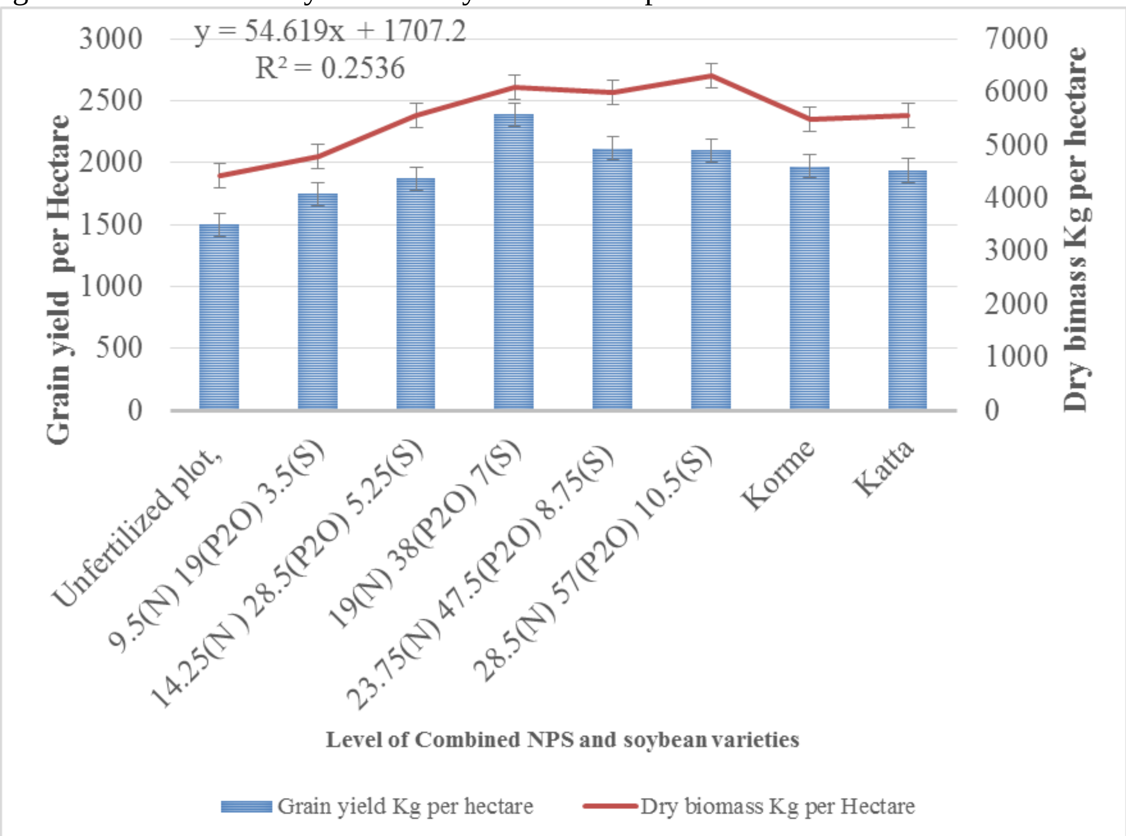

Figure 4. The effect of combined NPS chemical fertilizer levels on seeds yield and dry biomass of soybean

Table 6. The main effect of soybean varieties and blended NPS fertilizer rate on the nodulation parameter of soybean

NPS (kg ha^{-1})	NPPP	PL	NSPP	SPP	TSw (gm)	Grain yield (kg ha^{-1})	Dry biomass (kg ha^{-1})	Harvest index (%)
Unfertilized plot,	47.27 c	3.726c	2.627	107.3 c	151 c	1500 d	4427 c	34.84
9.5(N) 19(P2O) 3.5(S)	54.50 bc	3.803 bc	2.687	143.7 b	155 c	1743 c	4793 bc	37.06
14.25(N) 28.5(P2O) 5.25(S)	57.77 b	3.747c	2.713	154.9 b	157 bc	1873 c	5548 ab	33.78
19(N) 38(P2O) 7(S)	71.33a	3.921ab	2.813	203.9 a	160 abc	2390 a	6096 a	39.22
23.75(N) 47.5(P2O) 8.75(S)	61.53 ab	3.957a	2.820	171.5 b	166 ab	2114b	5989 a	35.29
28.5(N) 57(P2O) 10.5(S)	58.93 b	3.951ab	2.740	156.3 b	169 a	2098b	6306a	33.17
Mean	59	3.85	2.73	156	159.6	1953	5527	35.56
LSD (5%)	10.28	0.1497	NS	28.02	10.45	211.3	800.6	NS
Varieties								
Korme	66.5	3.880	2.767	156.5	156 b	1969	5490	35.96
Katta	70.1	3.821	2.700	156.0	163 a	1937	5563	35.16
Mean	68.3	3.85	2.73	256	159.5	1953	5527	35.56
LSD (5 %)	NS	NS	NS	NS	6.03	NS	NS	NS
CV%	14.7	3.2	5.3	15.0	5.5	9.0	12.1	9.5

Means followed by the same letters are not significantly different as judged by LSD test at 5% probability level, Number of Pods per Plant (NPPP), Pod length (cm), Number of Seeds per Pod (NSPP), Seed per plant (SPP), Thousand Seed Weight (TSw).

Table 7. Pearson Correlation Coefficients of different growth, yield and yield component parameters of soybean

	DF	DM	TNN	EN	NV	NDW	PH	LN	NPB	NPPP	NSPP	SPP	TSW	DBM	GY	HI
DF	1															
DM	0.56**	1														
TNN	0.73**	0.48**	1													
EN	0.72**	0.44**	0.98**	1												
NV	0.65**	0.34*	0.82**	0.81**	1											
NDW	0.65**	0.45**	0.80**	0.80**	0.76**	1										
PH	0.80**	0.73**	0.75**	0.75**	0.62**	0.75**	1									
LN	0.62**	0.51**	0.59**	0.61**	0.49**	0.72**	0.83**	1								
NPB	0.59**	0.42**	0.60**	0.62**	0.48**	0.46**	0.60**	0.54**	1							
NPPP	0.45**	0.37*	0.58**	0.60**	0.60**	0.59**	0.57**	0.29*	0.52**	1						
PL	0.38*	0.52**	0.33*	0.33*	0.19	0.34*	0.58**	0.40*	0.13	0.29						
NSPP	0.30	0.24	0.39*	0.43**	0.34*	0.46**	0.46**	0.44**	0.28	0.34*	1					
SPP	0.46**	0.43**	0.63**	0.64**	0.63**	0.66**	0.67**	0.69**	0.55**	0.96**	0.46**	1				
TSW	0.63**	0.21	0.62**	0.61**	0.69**	0.56**	0.52**	0.43**	0.32	0.39*	0.20	0.39*	1			
DBM	0.62**	0.50**	0.59**	0.58**	0.51**	0.62**	0.76**	0.74**	0.44**	0.61**	0.32*	0.64**	0.59**	1		
GY	0.53**	0.55**	0.62**	0.60**	0.58**	0.62**	0.79**	0.73**	0.38*	0.70**	0.34*	0.77**	0.55**	0.83**	1	
HI	-0.14	0.05	0.01	0.007	0.10	-0.04	-0.004	-0.08	-0.13	0.05	-0.04*	0.10	-0.07	-0.37	0.19	1

** Correlation is highly significant at 0.01 level * Correlation is significant at 0.05 level, DF= Days to 50% flowering, DM= Days to 90% maturity, TNN= Total nodule number, EN= Effective nodule, NV=Nodule volume, NDW= Nodule dry weight, PH= Plant height, LN= Leaf number, NPB= Number of primary branches, NPPP= Number of pods per plant, NSPP= Number of seeds per pod, SPP= Seeds per plant, TSW= Thousand seed weight, DBM= Dry biomass, GY= Grain yield, HI= Harvest index

Pearson correlation of growth yield and yield components of soybean varieties

Pearson correlation analysis between growth parameters, yield and yield components was presented in (Table 7). The Pearson correlation analysis showed that days to 50% emergence has highly significant at (P <0.01) and positively correlated with days to 50% flowering (0.50), days to 90% maturity (0.53) and plant height(0.48). Days to 50% flowering has highly significant at (P<0.01) and positively correlated with days to 90% maturity (0.56), total nodule number (0.73), effective nodule (0.73), nodule volume (0.65), nodule dry weight (0.65), plant height (0.80), leaf numbers (0.62), number of primary branches (0.59), thousand seed weight (0.63), dry biomass (0.0.62), seeds yield (0.53) and found highly significant at (P<0.01). This is due to it's a positive relationship with those parameters and contributes a great growth performances and yield parameters for the plants.

Conclusion

In the current study the application of 19(N) 38(P_2O) 7(S) kg ha^{-1} amalgamated chemical fertilizer show the highest number of nodules per plant, as well as the maximum seeds yield of soybean were obtained. Katta and Korme soybean varieties were have illustrated similar growth and seeds yield characters. Farmers of the West of Wollega zone widely cultivated soybean crop, the rate of using this amalgamated chemical fertilizer where not practiced by the farmers. Therefore, to increases the production and productivity of soybean in West Wollega zone the application of 19(N) 38(P_2O) 7(S) kg ha^{-1} with Katta and Korme were recommended for the highest yield and nodulation parameters for the farmers. For future work, it is recommended to demonstrate to go studies nutrient use efficiency soybean varieties, time and method of application of macro and micro nutrients, for enhancing soybean productivity.

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Authors' contributions

Tesfa Imenu and Kinde Lamessa contribute to design of the research proposal, field work, and data collection, analysis and interpretation of data using SAS software version 9.20 and writing manuscript. Dr.Tolera Abera assisted in analysis and interpretation of the data and also in writing the manuscript.

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