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EFFECTS OF NUTRIENT FOLIAR SPRAY ON SOYBEAN GROWTH AND YIELD (*GLYCINE MAX* (L.) MERRILL) IN SOUTH WEST NIGERIA

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Abstract. Pot and field trials were carried out on the roof top garden of the Department of Crop Protection and Environmental Biology, University of Ibadan, respectively the University Teaching and Research Farm, in order to study the effects of nutrient foliar spray on soybean growth and yield. TGX 1740-2F soybean variety was used in the experiment; nutrients were foliarly applied as exclusively N, NPK and NPKMg at the early flowering and early pod-filling growth stages. Plants were sprayed at the rate of 100 mg/L of water corresponding to each nutrient, while unsprayed plants served as control. The experimental design was a split plot with four replications. Results from the experiments showed that nutrient foliar spray, either singly or in combination, significantly (P= 0.05) enhanced the growth and yield of the TGX 1740-2F soybean variety, at the two growth stages. However, spraying nutrients during an early pod filling stage was significantly (P= 0.05) better than spraying at the early flowering growth stage. The highest yield of soybean was obtained by spraying NPK and NPKMg, but the optimum yield of soybean was obtained by spraying NPK at the pod filling stage of growth.

Key words: Soybean, stage of growth, foliar spray, nutrients, yield

INTRODUCTION

Soybean is a grain legume of considerable dietetic, industrial, medicinal and economic importance (Kale, 1985; INTSOY, 1989). In Nigeria, most soybean production is obtained in the middle belt zone consisting of Benue state and other adjoining states, where small-scale farmers have been growing soybean for about 50 years (IITA, 1980; Knipscheer and Ay, 1982). Nigeria's annual production has remained static at around 80 kt (Weiss 2000). To improve soybean yield, production is being extended to the southern rainforest zone of the country. Despite the high potential for rain-fed soybean production, the low productivity of soybean reported in these areas had been ascribed to environmental and soil factors.

In order to optimize soybean yield, it is therefore necessary to improve the plant environment and more efficient fertilization is one of such possibilities. Despite the known ability of legumes to fix atmospheric nitrogen, in symbiotic association with rhizobia, it has been demonstrated that supplementary fertilization can lead to improved performance of these crops (Tayo, 1981; Ashour and Thalooth, 1983; Kuepper, 2003; Mallarino, 2005). Apart from soil applications, foliar spray of nutrients has been shown to be a practical means of replenishing the reservoir of nutrients in the leaves of legumes during pod development, since the efficiency of nutrient uptake by roots, as well as symbiotic fixation activities are known to decline at this stage (Ashour and Thalooth, 1983).

Garcia and Hanway (1976) suggested that foliar application of N and other nutrients may be effective in extending the pod filling period by delaying senescence. Foliar application could be used to avoid the depletion of these nutrients in the leaves and also the resulting reduction in photosynthetic rate during this period, due to poor nutrient uptake from the soil and translocation of this element from the leaves to the developing seeds (Kuepper, 2003; Mallarino, 2005).

Soybean foliar fertilization during the pod filling stage has resulted in both positive and negative effects on soybean yields. One of the largest yield increases was reported by Garcia and Hanway (1976) when they described yield increases of up to 31% with foliar application of fertilizer solution containing NPKS as urea, K- polyphosphate and potassium sulphate four times, during the pod filling stage of growth (R5-R7).

Application of N during anthesis, either to the soil or to the foliage, increased fruit set, weight of pod, oil yield and protein in soybean seeds (Ashour and Thalooth, 1983). Vasilas et al. (1980) reported increased soybean yield with foliar fertilization, when other limiting factors particularly soil moisture were minimized and when measures were taken to prevent leaf burn. Leaf burn, according to Poole et al., (1983) occur when nutrients were applied midday, rather than in the early morning or late afternoon hours. Foliar application of needed nutrients can result in varying yield increases (Ashour and Thalooth, 1983). While the inclusion of S in the mixtures seldom increase yield (Mallarino 2005), the addition of Mg may however compliment N in leaf function and its inclusion as foliar nutrient spray may be necessary.

The objective of this study therefore was to assess the effect of foliar nutrient spray singly or in combinations during flowering and during pod filling stages, on the growth and yield of soybean.

MATERIAL AND METHODS

Pot Experiment

The pot experiment was carried out on the roof top garden of the Department of Crop Protection and Environmental Biology University of Ibadan to determine the effects of foliar spray of nutrients on the growth and yield of soybean. Pots were arranged in split plot experimental design with four replications. Each replicate was divided into two main plots to which early flowering and early pod filling stages of growth were assigned randomly. Each main plot was divided into four sub plots to which the four spray treatments viz: control (no spray) N, NPK and NPKMg were assigned.

The soybean variety used was TGX 1740-2F. It was a semi- determinate, erect variety. The seeds of this variety were collected from the International Institute of Tropical Agriculture (IITA) Ibadan. It was an early maturing variety with erect stem. Three seeds of this variety were planted per pot on the 12^{th} of April, 2002. Seed germination started 3 days later and seedlings were thinned to one plant per pot 2 weeks after sowing (WAS). Four WAS plants were sprayed against phytophagous insects using Delthrin 10EC, a systemic insecticide. Flowering started 6 WAS and designated plants were sprayed with nutrients at this stage, at the rate of 100 mg/litre of each nutrient. Plants started podding 8 WAS and were also sprayed at this stage.

Nitrogen was derived from Urea, phosphorus from sodium dihydrogen orthophosphate ($Na_2H_2PO_4.2H_2O$), potassium from potassium chloride (KCl) and magnesium from hydrated magnesium chloride ($MgCl_2.6H_2O$).

Sampling was done at 11 and 13 WAS. Four plants were sampled per treatment, by taking one plant from each replicate. For each plant harvested, data were taken on the following growth and yield parameters: number of leaves, leaf area (cm^2), stems height (cm), number of nodes, number of branches and number of pods. Additional yield data were also taken on the number of seeds per plant, seed dry wt per plant and 100- seed weight per plant, at maturity (13 WAS). The dry weights of leaves, stem, root, pods and seeds were taken after oven-drying the plant parts at 80°C for 2 days. The total plant dry weight was also calculated.

Data Analysis

The data generated were subjected to Analysis of Variance (ANOVA) using SAS software (Cary, 1999) and means were separated using LSD and SE at the 5% level of significance.

Field Experiment

The field trial was conducted at the Teaching and Research Farm of the University between July and October 2002. The plot was cleared and ploughed. The experimental plot was 8 m x 10 m in dimension. This was divided into four replicates each measuring 8 m x 2.1 m. There was a space of 0.5 m between successive replicates. Each block (replicate) was divided into two main plots to which the growth stages (early flowering and pod formation) were randomly assigned. Each main plot was similarly divided into four subplots to which the nutrient spray treatments N, NPK, NPKMg and control were assigned. The experimental design was split plot.

Planting of seeds was done on 25 July, 2002. Three seeds were sown per hole and the resulting seedlings were thinned to one plant per stand. Weeding was done at 2 and 6 WAS. Field-grown plants were also sprayed against insects using Delthrin 10 EC, 4 weeks after sowing. On the field, flowering started at 6.5 WAS, so that plants designated to be sprayed were sprayed with nutrients foliarly. Plants reached the R5 stage of growth at 8.5 WAS and were similarly sprayed foliarly. Destructive sampling of the plants was done at 11 WAS and 14 WAS, the latter period coinciding with plant maturity on the field.

Preparation of nutrient solutions and their foliar application, sampling and data collection and analysis were carried out as in the pot experiment.

RESULTS

Effect of stage of growth, of foliar spray on soybean (11 WAS) growth, development and yield

Plants sprayed at early pod filling stage produced significantly (P=0.05) larger leaf area, higher number of pods, higher dry weight of leaf, stem pod and total dry weight than plants sprayed at an early flowering growth stage (Table 1). EF and EP plants, however, had similar number of leaves, stem height, number of nodes, branches and root dry weight.

Effect of nutrients spray on growth, development and yield of soybean (11 WAS)

Plants sprayed with nutrients generally had significantly larger leaf area, higher number of branches, leaf dry weight and stem dry weight than control plants. Spaying NPKMg produced the tallest plants with the highest leaf dry weight. Only plants sprayed with NPK had significantly higher root and pod dry weight than control plants. Plants sprayed with NPK and NPKMg had a significantly higher total dry weight than control plants (Table 1).

Yield-wise, plants sprayed with NPK had the highest number of pods per plant. The pod dry weight of sprayed plants was generally significantly (P=0.05) higher than that of control plants (Table 1).

Interaction

Generally, plants sprayed with NPK at the early pod filing growth stage, had the highest values of most of the vegetative and dry weight parameters. Plants sprayed with NPKMg at the early pod filling growth stage, had the highest stem height, number of nodes and leaf dry weight. Plants sprayed with N in the early pod filling stage had the highest leaf area.

Plants sprayed with NPK at the early pod filling stage had the highest number of pods and pod dry weight (Table 1).

Effect of stage of growth, of nutrient application on vegetative
Dry weight and Yield Characters of Soybean in pots (13 WAS)

At 13 WAS, which coincided with plant maturity, plants sprayed at the early flowering stage had significantly higher values of leaf number, leaf area and leaf dry weight than plants sprayed at the pod-filling stage, in contrast to what was obtained at 11 WAS (Table 2).

Generally, the number of pods per plant, pod dry weight and indeed most other parameters of plants sprayed during early flowering, were not significantly different from those of plants sprayed during the early pod filling stage. However, plants sprayed during early pod fill stage had higher number of seeds, seed dry weight and significantly higher 100-seed weight (Table 2).

Effects of nutrient spray on growth development and yield of soybean in pots (13 WAS)

Plants sprayed with NPK had the highest mean number of all growth parameters measured, except leaf dry weight and total dry weight, where plants sprayed with NPK Mg had the highest values (Table 2).

Generally, plants sprayed with NPK had the highest number of pods, seeds and seed dry weight, while plants sprayed with NPK Mg had the highest pod dry weight and 100 -seed weight.

Interactions (**13WAS**)

Plants sprayed with NPK during the early flowering stage had the highest number of pods and seeds, while plants sprayed with NPK during the early pod filling stage had the highest pod dry weight. Plants sprayed with NPKMg during th early pod filling stage had the highest seed dry weight and 100 -seed weight (Table 2).

Field Experiment

Effect of stage of growth on growth, development and yield of soybean (11 WAS)

Plants sprayed during the early pod filling growth stage had significantly higher values of stem dry weight, root dry weight, seed dry weight and total dry weight than plants sprayed during an early flowering growth stage (Table 3).

Plants sprayed during early pod filling stage had significantly higher pod dry weight than plants sprayed during the early flowering growth stage even though both sets of plants had similar number of pods at 11 WAS (Table 3).

Effect of nutrients applied on growth, development and yield of soybean (11 WAS)

Plants sprayed with NPKMg had significantly the highest mean number of leaves, leaf area, leaf dry weight and total dry weight, while plants sprayed with NPK had the highest stem height, number of nodes number of branches, pods and seeds per pod, stem dry weight, pod dry weight and seed dry weight with total dry weight almost equal to that of NPKMg plants. Plants sprayed with N only had the highest value of root dry weight (Table 3).

The number of pods per plant and pod dry weight of plants sprayed with nutrients N, NPK and NPKMg were higher than control plants. In addition, the number of pods of plants sprayed was significantly higher than that of control plants. Similarly pod dry weights of sprayed plants were significantly higher than those of control plants.

Plants sprayed with NPK had the highest mean number of pods and pod dry weight (Table 3).

Interactions

Plants sprayed with NPK at the early pod filling stage were tallest, had the highest number of nodes, branches, pods; stem dry weight, pod dry weight seed dry weight and total dry weight, while plants sprayed with N at the early pod filling growth stage had the highest number of leaves and root dry weight. Plants sprayed with NPK at flowering had the highest number of seeds per pod and leaf dry weight (Table 3).

Effect of stage of growth on growth, development and yield of soybean on the field (13 WAS)

Spraying during the pod filling growth stage led to plants with higher number of leaves, larger leaf area, greater height, with significantly higher number of branches, pods, leaf stem and total dry weight than spraying during an early pod filling stage, in contrast to what was obtained at 11 WAS.

Generally the number of pods of plants sprayed during the early pod filling stage of growth was higher and significantly different from those plants sprayed during an the early pod filling stage of growth, as obtained in the pot experiment (Table 4).

Effect of nutrients applied on growth, development and yield of soybean on the field (13WAS)

Plants sprayed with NPK had the highest number of all the growth parameters measured except leaf area, leaf dry weight and stem height, whereas plants sprayed with N had the highest leaf area and stem height.

Plants sprayed with nutrients were significantly different from control plants, in respect of higher values of plant height, number of branches, number of seeds per plant, and stem dry weight. Specifically, plants sprayed with NPK had significantly the highest number of nodes, pods per plant, pod dry weight, seed dry weight and total dry weight (Table 4).

Interactions

Plants sprayed with NPK during the early flowering stage had the highest number of leaves, leaf area, number of nodes and numbers of pods, number of seeds per pod, stem dry weight and leaf dry weight. Plants sprayed with N during the early pod filling stage were the tallest. Plants sprayed with NPK and NPKmg during the early flowering stage had the highest value of root dry weight and plants sprayed with NPK during the early pod filling stage had the highest number of branches. Similarly, plants sprayed with NPK in the early flowering growth stage had the highest number of pods and number of seeds per pod, while plants sprayed with NPK in the early pod filling stage had the highest pod dry weight and seed per plant (Table 4).

DISCUSSION

The results of this study showed that the foliar application of essential mineral nutrients, either singly or in combinations, was consistently beneficial to soybean growth, development and yield, both in pots and on the field. Similarly, foliar spray during the flowering and pod filling stages, also enhanced the performance of soybean. This result

agrees with the work of Tayo (1981), who reported that the application of essential nutrients was beneficial to the yield of cowpea.

Plants sprayed during the early pod filling stage of growth, initially had higher values of some vegetative characters than plants sprayed during the early flowering growth stage but, statistically, not significantly different. This was probably due to the fact that all plants had reached the peak of vegetative growth before spraying was done. The fact that spraying during the early pod filling growth stage would be ultimately better than spraying at early flowering, has started manifesting at this initial stage, since the former plants had significantly higher values of most parameters studied.

Spraying NPK during the pod filling stage enhanced growth development and yield of plants in pots as well as on the field, compared with other treatment combinations. This agrees with the work of Dang et al (1984) that combined application of N and P resulted in the increase of soybean dry matter. According to Hanway (1980), foliar application of nutrients during seed filling appears to be a promising method for increasing soybean yields. According to Ashour and Thalooth (1983), foliar application of N during anthesis resulted in increased seed yield. But in this study, foliar application of N only increased plant leaf area, when applied at an early pod-filling growth stage of the plant. Spraying plants with NPKMg during pod filling growth stage increased stem height and leaf dry weight, but not as much as NPK did.

Furthermore, this study has shown that the combination of NPKMg did not give a better performance than NPK, despite the fact that Mg is also important in chlorophyll formation. This could be that the addition of Mg was no longer necessary since its role in chlorophyll formation and leaf growth, amongst other functions, might have been adequately taken care of N. Besides, the plants may have received enough Mg from the soil making the additional foliar application of Mg unnecessary. This is particularly good as the additional cost of including Mg is removed.

The interaction Nutrient spray x stage of growth showed that spraying NPK during pod filling stage gave the most optimum performance of soybean, in terms of growth and yield.

In contrast to the work of Parker and Boswell (1980), who obtained leaf burn leading to reduced yield, leaf burn did not occur in this study, thus indicating that the concentration of nutrient solutions used was optimum.

The spraying during the pod filling stage was more effective than during flowering, probably because nutrients applied during pod filling were readily used for photosynthesis and the assimilates quickly mobilized for grain filling, which was the priority of the plants at that stage of growth.

In conclusion, it appears that nutrient spraying enhanced soybean growth, development and yield and spraying in the pod filling stage is better than during flowering, in terms of yield. As for the nutrient combinations, both NPK and NPK Mg appear to give the highest yield of soybeans especially during the pod filling stage. Since the performance of NPK is similar to that of NPK Mg, in terms of cost benefit ratio, it is advisable to adhere to NPK during the pod filling stage of growth.

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REZUMAT

EFECTELE FERTILIZĂRII FOLIARE ASUPRA CREŞTERII ŞI PRODUCŢIEI LA SOIA (*GLYCINE MAX* (L.) MERRILL) ÎN SUD-VESTUL NIGERIEI

Ghivece cu plante de soia şi loturi în câmp au fost studiate la Departamentul de Protecţie a Recoltelor şi Biologie a Mediului, Universitatea din Ibadan, şi la Universitatea Didactică şi de Cercetare a Fermelor, Nigeria, pentru estimarea efectului fertilizării foliare asupra creşterii plantelor şi producţiei la soia. Soiul utilizat în experiment a fost TGX 1740-2F, iar îngrăşămintele foliare aplicate au fost azotul, NPK, şi NPKMg, în primele faze ale înfloririi şi creşterii plantelor de soia. Plantele au fost fertilizate cu o diluţie de 100 mg/l pentru fiecare nutrient, iar plantele nefertilizate au servit ca variante martor (control). Experienţa s-a organizat în patru repetiţii. Rezultatele obţinute au demonstrat că fertilizarea foliară, cu îngrăşăminte simple sau combinate, măreşte semnificativ (P=0,05) creşterea plantelor şi producţia de soia la cultivarul TGX 1740-2F, în al doilea stadiu de dezvoltare. S-a constatat că fertilizarea foliară în stadiul de păstaie a fost semnificativ mai bună (P=0,05) decât fertilizarea în faza de înflorire a plantelor. Cea mai mare producţie s-a obţinut prin fertilizare cu NPK şi NPKMg, dar optimul de producţie s-a obţinut prun fertilizare cu NPK, în stadiul de păstaie.

Table 1

Effects of foliar spray of nutrients on growth and yield characters of soybean, 11 weeks after sowing (WAS)

Treatment combinations	Number of leaves	Leaf area	Stem height	Number of nodes	Number of branches	Number of pods	Leaf dry weight (g)	Stem dry weight (g)	Root dry weight (g)	Pod dry weight (g)	Total dry weight (g)
EF	43.13	721.98	46.60	17.06	7.00	62.06	8.06	6.30	3.36	10.24	27.97
Ep	45.44	1113.60	50.47	17.06	8.25	75.19	10.21	7.94	3.59	12.75	34.55
LSD (P<0.05)	3.65	128.47	5.44	1.62	1.63	8.25	1.16	1.52	0.70	2.21	4.57
Nutrients											
N	45.63	986.29	45.81	16.50	8.25	67.63	8.85	7.00	3.32	10.51	29.67
NPK	47.50	972.48	49.63	18.13	8.38	71.88	10.21	8.65	4.12	13.65	36.63
NPKMg	47.25	964.39	50.36	17.25	8.00	70.88	10.63	7.39	3.65	11.84	33.51
Control	46.75	748.02	48.34	16.37	5.88	64.13	6.85	5.45	2.83	9.99	25.12
LSD (P<0.05)	5.16	181.69	7.69	2.30	2.30	11.67	1.64	2.15	0.98	3.00	6.46
Interactions											
EFXN	45.25	752.16	45.05	17.00	8.25	59.25	7.48	5.99	3.13	8.81	25.40
EFXNPK	42.75	742.09	47.25	18.00	6.75	58.00	8.52	7.10	4.03	11.81	31.45
EFX NPKMg	45.75	760.10	47.85	16.25	7.75	68.75	9.17	6.93	3.30	10.77	30.10
CONTROL	38.75	633.59	46.25	17.00	5.25	62.25	7.08	5.17	3.00	9.59	24.86
EPXN	46.00	1220.42	46.58	16.00	8.25	76.00	10.22	8.00	3.49	12.22	33.93
EPXNPK	52.25	1202.87	52.00	18.25	10.00	85.75	11.91	10.20	4.21	15.49	41.81
EPX NPKMg	48.75	1168.67	52.88	18.25	8.25	73.00	12.08	7.85	4.01	12.91	36.85
S.E	1.95	84.81	1.02	0.36	0.51	3.31	0.75	0.69	0.20	0.75	2.16

Table 2

Effects of foliar spray of nutrients on growth and yield characters of soybean, 13 weeks after sowing (WAS)

Treatment Stage of growth	Number of leaves	Leaf area (cm^2)	Number of nodes	Stem height (cm)	Number of branches	Number of pods	Number of seeds	Leaf dry weight (g)	Stem dry weights(g)	Root dry weight (g)	Pod dry weight (g)	Seed dry weight (g)	100 seed dry weight (g)	Total dry weight (g)
EF	34.31	790.50	16.94	48.50	8.50	77.50	150.44	6.40	6.54	4.06	23.12	14.55	9.39	40.12
EP	23.94	562.30	17.00	46.28	8.19	74.19	152.13	4.37	6.79	3.62	21.36	16.39	10.77	36.14
LSD (P<0.05)	7.83	214.95	2.02	6.89	1.26	10.07	22.91	1.79	1.38	0.95	3.60	2.64	1.06	5.81
Nutrients														
N	26.75	678.90	16.00	42.71	7.63	68.00	140.13	4.70	6.35	3.18	20.78	14.37	9.66	35.01
NPK	32.00	736.40	17.63	52.04	8.63	83.38	166.88	5.90	6.76	4.34	23.54	16.72	9.86	40.54
NPKMg	28.75	679.20	16.50	44.78	8.63	79.0	155.25	6.37	6.35	4.09	24.15	16.45	10.70	40.96
Control	29.00	611.10	17.75	49.10	8.50	73.00	142.88	4.58	6.14	3.75	20.51	14.33	10.10	34.98
LSD(P<0.05)	11.08	303.98	2.86	9.74	1.79	14.24	32.40	2.53	1.95	1.35	5.09	3.74	1.49	8.22
Interactions														
EF XN	31.00	721.04	17.50	46.93	8.00	67.25	136.50	5.14	6.28	3.36	19.80	13.54	8.68	34.58
EF X NPK	37.00	929.52	16.00	50.30	9.75	90.75	169.50	6.55	6.76	4.78	23.38	15.86	9.54	41.47
EF X NPKMg	33.00	731.57	17.50	49.13	9.00	79.00	148.75	7.58	7.01	4.02	22.59		10.21	41.20
CONTROL	36.25	779.68	16.75	45.80	7.25	73.00	147.00	6.35	6.12	4.08	19.70	13.47	9.13	36.25
EP X N	22.50	636.71	14.50	38.50	7.25	68.75	143.75	4.26	6.41	3.00	21.76	15.21	10.65	35.43
EP X NPK	27.00	543.27	19.25	53.78	7.50	76.00	164.25	5.24	6.76	3.91	23.70	17.04	10.17	39.61
EP X NPKMg	24.50	626.76	15.50	40.43	8.25	79.00	161.75	5.17	7.85	4.71	25.72	18.12	11.19	42.91
S.E	2.14	52.82	0.57	1.92	0.37	2.61	4.36	0.52	0.20	0.19	0.72	0.56	0.32	1.23

Table 3

Effects of foliar spray of nutrients on growth and yield characters of soybean, 11 weeks after sowing (WAS)

Treatments/ Stage of growth	# of Leaves	Leaf Area (cm^2)	Stem Ht. (cm)	# of Nodes	# of Branches	# of pods	# of seeds/ plant	Leaf dry wt/plant (g)	Stem dry wt/plant (g)	Root dry wt/plant (g)	Pod dry wt/plant (g)	Seed dry wt/plant (g)	Total dry wt/plant (g)
EF	50.06	1224.33	65.50	18.19	7.94	77.27	171.25	11.29	9.26	2.48	15.43	8.51	38.46
EP	50.56	1266.46	67.81	18.69	8.28	80.44	170.25	11.49	10.28	3.23	16.52	9.23	41.52
LSD (P<0.05)	3.40	130.24	10.01	1.34	0.65	6.50	10.36	0.80	0.61	0.23	0.87	0.36	2.06
Nutrients													
N	50.75	1250.11	60.63	17.63	8.00	70.75	165.50	12.01	9.29	2.78	15.60	8.75	38.51
NPK	50.75	1244.18	74.13	16.63	8.50	75.00	180.75	10.84	10.61	2.72	17.02	9.05	40.92
NPKMg	51.00	1290.35	71.38	19.25	8.00	87.25	172.25	10.57	9.94	2.75	16.09	8.72	40.94
Control	48.75	1196.94	60.50	17.25	7.88	82.38	164.50	12.16	9.22	3.16	15.52	8.97	39.91
LSD (P<0.05)	2.23	89.77	6.99	0.90	0.47	4.53	7.06	0.72	0.51	0.27	0.69	0.35	1.82
Interactions													
EF x N	50.00	1245.20	52.25	17.00	7.50	73.5	171.50	10.28	8.45	2.37	15.07	8.56	36.17
EF x NPK	50.75	1285.4	73.25	19.25	8.00	82.75	182.25	10.31	9.94	2.51	16.39	8.76	39.15
EFxNPKMg	51.25	1378.3	73.25	19.25	8.03	84.50	170.00	13.59	9.90	2.61	16.04	8.64	42.14
EP x N	51.50	1255.03	69.00	18.25	8.50	76.50	169.50	11.40	10.14	3.19	15.48	8.94	40.21
EP x NPK	50.75	1202.95	75.00	20.00	9.00	91.75	179.25	10.83	11.25	2.93	17.64	9.34	42.65
EPxNPKMg	50.75	1202.4	69.50	19.25	7.75	80.25	174.50	10.73	9.99	2.89	16.13	8.80	39.74
Control	44.00	898.15	57.75	19.00	6.75	64.25	175.75	9.63	8.33	2.54	16.14	9.50	36.64
S.E	0.77	30.75	2.60	0.35	0.16	1.91	2.65	0.27	0.20	0.85	0.26	0.12	0.60

Table 4

Effects of foliar spray of nutrients on growth and yield characters of soybean, 13 weeks after sowing (WAS)

Treatments/ Stage of growth	# of Leaves	Leaf Area (cm^2)	Stem Ht. (cm)	# of Nodes	# of Branches	# of pods	# of seeds/ plant	Leaf dry wt/plant (g)	Stem dry wt/plant (g)	Root dry wt/plant (g)	Pod dry wt/plant (g)	Seed dry wt/plant (g)	Total dry wt/plant (g)
EF	38.38	869.81	70.53	19.63	8.50	86.13	207.13	8.47	10.87	1.63	21.12	16.50	42.09
EP	35.81	750.16	69.94	18.31	7.75	77.25	196.81	7.69	10.20	1.59	20.14	16.23	39.56
LSD (P<0.05)	2.10	88.65	8.40	0.73	0.47	7.85	12.13	0.46	0.49	0.10	1.65	0.77	2.18
Nutrients													
N	37.50	875.29	74.88	18.88	8.00	84.38	203.38	9.82	10.45	1.54	20.86	16.47	42.67
NPK	38.13	832.39	69.75	19.88	8.50	84.38	208.63	8.39	10.83	1.68	21.63	17.10	42.53
NPKMg	35.38	749.59	73.38	18.25	8.25	80.75	208.88	7.31	10.72	1.63	20.15	16.51	39.81
Control	37.38	782.68	62.94	18.88	7.75	77.25	192.00	8.80	10.13	1.59	19.89	15.39	40.41
LSD (P<0.05)	1.75	72.30	6.03	0.64	0.41	6.28	9.10	0.45	0.41	0.07	1.18	0.57	1.78
Interactions													
EF x N	36.50	462.85	68.75	18.15	8.25	84.25	202.75	7.97	10.28	1.50	20.81	16.07	40.56
EF x NPK	39.75	912.38	67.75	20.75	8.50	87.75	211.25	8.71	11.26	1.68	22.09	17.05	43.74
EFxNPKMg	36.50	786.80	77.50	19.25	8.50	82.25	206.25	7.25	11.01	1.68	19.87	16.64	39.81
EP x N	38.50	887.73	81.00	19.00	7.75	84.50	204.00	7.67	10.61	1.57	20.83	16.87	40.68
EP x NPK	36.50	752.42	71.75	19.00	8.50	81.00	206.00	8.17	10.41	1.68	21.06	17.15	41.42
EPxNPKMg	34.25	712.38	69.25	17.25	8.00	79.25	201.50	7.38	10.44	1.59	20.44	16.39	39.85
Control	34.00	648.15	57.75	18.00	7.75	64.25	175.75	7.63	9.33	1.54	18.14	14.50	36.64
S.E	0.62	25.78	2.19	0.24	0.15	2.18	3.25	0.18	0.15	0.52	0.42	0.22	0.62