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EFFECT OF FOLIAR SPRAYS OF NITRATE SALTS ON MORPHO-PHYSIOLOGICAL TRAITS AND YIELD OF GREEN GRAM

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Abstract:
Present investigation was undertaken at farm of Botany Section, College of Agriculture, Nagpur during *kharif* 2013-14 to study the effect of two foliar sprays of $Ca(NO_3)_2$ (0.25, 0.50, 0.75 and 1%) and KNO_3 (0.25, 0.50, 0.75 and 1%) on morpho-physiological traits and yield of green gram. Data revealed that foliar application of 0.50% KNO_3 followed by 0.50% $Ca(NO_3)_2$ significantly increased plant height, leaf area, number of branches, dry matter, RGR , NAR, number of pods plant^{-1}, 100 seed weight, yield plant^{-1} and plot^{-1}. Among the foliar spray treatments spray of 0.5% $Ca(NO_3)_2$ and 0.5% KNO_3 increased grain yield by 23 and 19% respectively over control.
Keywords: Green gram, $Ca(NO_3)_2$, KNO_3, morpho-physiological characters, yield

Introduction:

Green gram is one of the pulse crop cultivated in India. Green gram have excellent source of high quality protein. It occupies prominent place in Indian agriculture, its popularity got increased because of tonnage capacity. It ranks third among all pulses grown in India after chickpea and pigeonpea.

Nitrate (NO_3^-) is easily absorbed by plants at high rates. Unlike urea or ammonium, it is immediately available as a nutrient. Nitrate is highly mobile in the soil and reaches the plant roots quickly. Applying nitrogen as ammonium nitrate or calcium ammonium nitrate provides an instant nutrient supply.

Calcium is known to exert important consequence on several physiological processes in plants like ion transport, translocation of carbohydrates, proteins, and their storage during seed formation and other enzymatic activities. Calcium has been reported to inhibit Na^+ uptake and thereby reduce its adverse effect on seed germination (Nayyar, 2003) as well as increase plant growth (Munns, 2002).

Potassium affects respiration, photosynthesis, chlorophyll development, water content of leaves, carbon dioxide (Co_2) assimilation, and carbon movement. Potassium also has an important role in the translocation of photosynthates from sources to sinks (Cakmak *et al.*, 1994).

Hence, present study was undertaken to find out the effect of $Ca(NO_3)_2$ and KNO_3 with different concentrations to improve morpho-physiological parameters and yield of green gram.

Material and Methods:

A field experiment on soybean was conducted at an experimental farm of Botany section, College of Agriculture, Nagpur. The present investigation was undertaken during the *kharif* season of 2013-2014. The field experiment was laid out in Randomized block Design (RBD) with three replications consisting of nine treatments with different concentrations of $Ca(NO_3)_2$ (0.25, 0.50, 0.75 and 1%) and KNO_3 (0.25, 0.50, 0.75 and 1%). Spraying of nitrate salts ($Ca(NO_3)_2$ and KNO_3)was done two times at 25 and 35 DAS with hand sprayer. Plot size of individual treatment was gross 3.00 m x 2.20 m and net 2.40 m x 2.00 m.Observations on plant height, number of branches, leaf area and dry matter were recorded at different stages i.e. at 40 and 55 DAS. RGR and NAR were recorded and calculated at 40-55 DAS. Number of pods plant^{-1}, 100 seed weight, yield plant^{-1} and plot^{-1} were also noted. The crop was kept free from disease and pest during the growth period. Harvesting was under taken after the crop attained maturity. Data was analysed by statistical method suggested by Panse and Sukhatme (1954).

Results and Discussion:

Plant height

Significantly highest plant height was recorded with the foliar application of 0.50% KNO_3 (T_7) followed by foliar application of 0.50% $Ca(NO_3)_2$ (T_3), 0.75% KNO_3 (T_8) and 0.75% $Ca(NO_3)_2$ (T_4) when compared with control (T_1) and rest of the treatments under observation. At 55DAS foliar application of 0.50% KNO_3 (T_7) showed significantly maximum plant height followed by foliar application of 0.50% $Ca(NO_3)_2$ (T_3), 0.75% KNO_3 (T_8) when compared with control (T_1) and

rest of the treatments under observation. Similarly foliar application of 0.75% Ca $(NO_3)_2$ (T_4) and 1% KNO_3 (T_9) increased significantly plant height when compared with control (T_1). Kundu and Sarkar (2009) evaluated the effect of foliar nutrition of potassium nitrate (KNO_3) and calcium nitrate ($Ca(NO_3)_2$) on growth and yield of rice (*Oryza sativa* L.). Plant height increased significantly due to the foliar application of 0.406% $Ca(NO_3)_2$ followed by 0.50% KNO_3 during 50% flowering stage. Sarkar and Mallick (2009) revealed that soil application of nitrogen up to 120 kg ha^{-1} along with 60 kg S ha^{-1} and foliar nutrition of 0.406% $Ca(NO_3)_2$ improved the plant height in sunflower. Waraich *et al.* (2011) observed that foliar application of 2% KNO_3 increased plant height in cotton.

Number of branches plant^{-1}

At 40 DAS the significantly highest number of branches plant $^{-1}$ was recorded with the foliar application of 0.50% KNO_3 (T_7) followed by foliar application of 0.50% $Ca(NO_3)_2$ (T_3), when compared with control (T_1) and rest of the treatments under observation. Similarly foliar application of 0.75% KNO_3 (T_8), 0.75% $Ca(NO_3)_2$ (T_4) and 1% KNO_3 (T_9) increased more number of branches plant^{-1} when compared with control (T_1). At 55 DAS significantly highest number of branches plant^{-1} was recorded with the foliar application of 0.50% KNO_3 (T_7) followed by foliar application of 0.50% $Ca(NO_3)_2$ (T_3) when compared with control (T_1) and rest of the treatments under observation. Similarly foliar application of 0.75% KNO_3 (T_8), 0.75% $Ca(NO_3)_2$ (T_4), 1% KNO_3 (T_9) and 1% $Ca(NO_3)_2$) (T_5) in a descending manner also significantly increased number of branches plant^{-1} when compared with control (T_1) and rest of the treatments. Treatment T_6 (0.25% KNO_3) also showed their significance over control treatment T_1 (control), but treatment T_2 (0.25% $Ca(NO_3)_2$) remained at par with T_1(control). Sarkar and Mallick (2009) recorded that soil application of nitrogen up to 120 kg ha^{-1} along with 60 kg S ha^{-1} and foliar nutrition of 0.406% $Ca(NO_3)_2$ increased the number of branches in sunflower.

Leaf area plant^{-1}

At 40 DAS significantly maximum leaf area was noticed with the foliar application of 0.50% KNO_3 (T_7) followed by foliar application of 0.50% $Ca(NO_3)_2$ (T_3) and 0.75% KNO_3 (T_8) when compared with control (T_1) and rest of the treatments under observation. Similarly foliar application of 0.75% $Ca(NO_3)_2$ (T_4), 1% KNO_3 (T_9) and 1% $Ca(NO_3)_2$ (T_5) increased more leaf area over the control (T_1). At 55 DAS foliar application of 0.50% KNO_3 (T_7) followed by foliar application of 0.50% $Ca(NO_3)_2$ (T_3) recorded significantly more leaf area when compared with control (T_1) and rest of the treatments under observation. Similarly foliar application of 0.75% KNO_3 (T_8), 0.75% Ca $(NO_3)_2$ (T_4), 1% KNO_3 (T_9) and 1% $Ca(NO_3)_2$ (T_5) also recorded significantly more leaf area when compared with control and other treatments under study. Basole *et al.* (2003) reported that foliar application of 50 ppm NAA and nutrients ($FeSO_4$, KNO_3, $ZnSO_4$ and $MgSO_4$ 0.55%) increased leaf area plant^{-1} over control in soybean. Sarkar *et al.* (2008) revealed that foliar spray of 0.25% KNO_3 at anthesis increased leaf area index of rice genotypes.

Dry matter plant^{-1}

At 40 DAS significantly maximum dry matter was noticed with the foliar application of 0. 50% KNO_3 (T_7) followed by foliar application of 0.50% $Ca(NO_3)_2$ (T_3) and 0.75% KNO_3 (T_8) when compared with control (T_1) and rest of the treatments under observations. Similarly foliar application of 0.75% $Ca(NO_3)_2$ (T_4) and 1% KNO_3 (T_9) recorded significantly maximum dry matter when compared with control (T_1) and other remaining treatments. At 55 DAS significantly highest dry matter was noticed with the foliar application of 0.50% KNO_3 (T_7) followed by foliar application of 0.50% $Ca(NO_3)_2$ (T_3) when compared with control (T_1) and rest of the treatments under study. Similarly foliar application of 0.75% KNO_3 (T_8), 0.75% Ca $(NO_3)_2$ (T_4), 1% KNO_3 (T_9) and 1% $Ca(NO_3)_2$ (T_5) recorded significantly maximum dry matter production in a descending manner when compared with control (T_1) and rest of treatments. Jayarani Reddy *et al.* (2004) studied the effect of potassium nitrate and NAA on growth and yield of red gram. The foliar application of NAA 20 ppm + KNO_3 0.5 per cent significantly increased the dry matter production of red gram over the control. Sarkar *et al.* (2008) reported that foliar spray of 0.25% KNO_3 at anthesis increased dry matter accumulation in rice.

Relative growth rate

The data recorded about the RGR at 40 – 55 DAS all the treatments gave significant variation. Significantly highest RGR was recorded with the foliar application of 0.50% KNO_3 (T_7) followed by foliar application of 0.50% $Ca(NO_3)_2$ (T_3), 0.75% KNO_3 (T_8) and 0.75% Ca $(NO_3)_2$ (T_4) when compared with control (T_1) and rest of the treatments under observation. Similarity foliar application of 1% KNO_3 (T_9) and 1% $Ca(NO_3)_2$ (T_5) recorded significantly more RGR when compared with control (T_1) and rest of the treatments under observation. Sarkar and Pal (2006) studied the effect of pre-sowing seed

treatments and foliar spraying of nitrate salts on the growth and yield of green gram (*Vigna radiata*). Pre-sowing seed treatments improved growth parameters like crop growth rate, relative growth rate and among the foliar spray treatments, spray of 0.406% $Ca(NO_3)_2$ and 0.5% KNO_3 exhibited maximum relative growth rate over the control.

Net assimilation rate

At 40 – 55 DAS data showed significant variation in respect of NAR. At this stage foliar application of 0.50% KNO_3 (T_7) followed by foliar application of 0.50% $Ca(NO_3)_2$ (T_3), 0.75% KNO_3 (T_8) and 0.75% Ca $(NO_3)_2$ (T_4) significantly increased NAR when compared with control (T_1) and rest of the treatments under observation. But treatments T_9 (1% KNO_3), T_5 (1% $Ca(NO_3)_2$), T_6 (0.25% KNO_3) and T_2 (0.25% $Ca(NO_3)_2$) were found at par with treatment T_1 (control) in NAR at this stage of observation. Sarkar and Pal (2006) studied the effect of pre-sowing seed treatments of rhizobium (*Bradyrhizobium japonicum*) with foliar spray of nitrate salts (0.5% KNO_3 and 0.406 % $Ca(NO_3)_2$ on the growth and yield of green gram and found improvement in the net assimilation rate over control. Sarkar *et al.* (2008) reported that foliar spray of 0.25% KNO_3 at anthesis increased net assimilation rate in rice.

Number of pods plant^{-1}

Data in respect of pods plant^{-1} were recorded at harvesting stage are presented in table 2. Significantly more number of pods plant^{-1} were recorded with the foliar application of 0.50% KNO_3 (T_7) followed by foliar application of 0.50% $Ca(NO_3)_2$ (T_3) and 0.75% KNO_3 (T_8) when compared with control (T_1) and rest of the treatments under observation. Similarly foliar application of 0.75% $Ca(NO_3)_2$ (T_4), 1% KNO_3 (T_9), 1% $Ca(NO_3)_2$ (T_5), 0.25% KNO_3 (T_6) and 0.25% $Ca(NO_3)_2$ (T_2) in a descending manner also increased number of pods plant^{-1} over the control (T_1). All the treatments were significantly superior over control (T_1). Pal and Keorah (2012) conducted a field experiment to find out the effect of nitrate salts on green gram. Foliar spray of nitrate salts (i.e. 0.5% potassium nitrate with 0.4% calcium nitrate) increased the number of pods plant^{-1} as compared to control.

100 seed weight

Data obtained about 100 seed weight are given in table 2.Significantly maximum 100 seed weight was recorded by the foliar application of 0.50% KNO_3 (T_7) followed by application of 0.50% $Ca(NO_3)_2$ (T_3), 0.75% KNO_3 (T_8), 0.75% $Ca(NO_3)_2$ (T_4) and 1% KNO_3 (T_9) in a descending manner and these treatments were found significantly superior over control (T_1) and rest of the treatments under study. Treatments T_5 (1% $Ca(NO_3)_2$), T_6 (0.25% KNO_3) and T_2 (0.25% $Ca(NO_3)_2$) were found at par with treatment T_1 (control). Sharma *et al.* (2000) found that foliar spray of 0.5% KNO_3 at 50% flowering in grasspea gave maximum values of 1000 seed weight which were significantly superior to water spray and unsprayed control. Sarkar *et al.* (2008) revealed that foliar spray of 0.25% KNO_3 at anthesis increased test weight of rice grains.

Seed yield plant^{-1} (g) and plot^{-1} (kg)

Data regarding seed yield plant^{-1}, plot^{-1} are given in table 2. Seed yield is the economic yield which is final results of physiological activities of plants. Economic yield is that part of biomass that is converted into economic product. Seed yield is influenced by morpho-physiological factors such as plant height, total dry matter production, leaf area and are considered as yield contributing parameters. Significantly maximum seed yield plant^{-1}, plot^{-1}were recorded with the foliar application of 0.50% KNO_3 (T_7) followed by foliar application of 0.50% $Ca(NO_3)_2$ (T_3), 0.75% KNO_3 (T_8) and 0.75% $Ca(NO_3)_2$ (T_4) when compared with control (T_1) and rest of the treatments. While, treatments T_9 (1% KNO_3), T_5 (1% $Ca(NO_3)_2$), T_6 (0.25% KNO_3) and T_2 (0.25% Ca $(NO_3)_2$) were found at par with treatment T_1 (control). Sarkar and Pal (2006) studied the effect of pre-sowing seed treatment with rhizobium (*Bradyrhizobium japonicum*) and foliar spraying of nitrate salts on the growth and yield of green gram (*Vigna radiata*). Foliar spray of nitrate salts during 50% flowering stage showed beneficial effect on growth parameters and yield attributes, thereby increasing grain yield by 7 to 23%. Among the foliar spray treatments, spray of 0.5% $Ca(NO_3)_2$ and 0.5% KNO_3 exhibited maximum increase in grain yield over the control (23 and 19%, respectively).

Table. 1- Effect of foliar sprays of nitrate salts on morpho-physiological parameters of green gram

Treatments	Plant height (cm)		No of branches plant^{-1}		Leaf area plant^{-1} (dm^2)		Total dry matter plant^{-1}(g)	
	40 DAS	55 DAS	40 DAS	55 DAS	40 DAS	55 DAS	40DAS	55 DAS
T_1 (Control)	29.67	51.33	2.47	2.60	2.78	3.81	3.39	4.56
T_2(0.25% $Ca(NO_3)_2$)	31.43	55.20	2.60	3.20	2.85	4.03	3.77	5.38
T_3 (0.50% $Ca(NO_3)_2$)	34.71	64.54	4.40	4.87	4.30	5.59	5.59	11.21
T_4 (0.75% $Ca(NO_3)_2$)	33.16	59.30	3.80	4.20	3.87	5.15	4.94	9.19
T_5 (1% $Ca(NO_3)_2$)	32.08	56.43	3.07	3.93	3.49	4.85	4.23	7.55
T_6 (0.25% KNO_3)	31.94	55.98	2.80	3.33	3.22	4.25	4.07	5.89
T_7 (0.50% KNO_3)	36.01	66.10	4.93	5.40	4.62	6.01	6.30	12.67
T_8 (0.75% KNO_3)	33.35	60.26	4.07	4.53	4.23	5.23	5.33	10.06
T_9 (1% KNO_3)	32.31	58.38	3.20	4.13	3.78	4.99	4.78	8.57
SE(m) ±	0.957	1.9449	0.2293	0.2194	0.1775	0.2364	0.335	0.5035
CD at 5%	2.869	5.8311	0.6874	0.6578	0.5322	0.7089	1.004	1.509

Table. 2- Effect of foliar sprays of nitrate salts on RGR, NAR and yield contributing characters of green gram

Treatments	RGR (g g^{-1} day^{-1}) 40-55 DAS	NAR (g dm^{-2} day^{-1}) 40-55 DAS	No. of pods plant^{-1}	Seed yield plant^{-1} (g)	Seed yield plot^{-1} (kg)
T_1 (Control)	0.0221	0.03146	13.97	2.60	0.416
T_2(0.25% $Ca(NO_3)_2$)	0.0236	0.07610	16.90	2.70	0.432
T_3 (0.50% $Ca(NO_3)_2$)	0.0464	0.06192	19.13	3.09	0.494
T_4 (0.75% $Ca(NO_3)_2$)	0.0411	0.05355	18.10	2.92	0.467
T_5 (1% $Ca(NO_3)_2$)	0.0382	0.03352	17.83	2.85	0.456
T_6 (0.25% KNO_3)	0.0243	0.08199	17.43	2.79	0.446
T_7 (0.50% KNO_3)	0.0476	0.06741	20.20	3.20	0.512
T_8 (0.75% KNO_3)	0.0423	0.05807	18.76	2.97	0.475
T_9 (1% KNO_3)	0.0389	0.0113	18.00	2.87	0.459
SE(m) ±	0.0032	0.0337	0.647	0.1051	0.0151
CD at 5%	0.0094	0.0337	1.939	0.3150	0.0452

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