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Research Article

A COMPARATIVE STUDY OF PLANT GROWTH REGULATORS ON MORPHOLOGICAL, SEED YIELD AND QUALITY PARAMETERS OF GREENGRAM

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ABSTRACT: A field experiment was conducted to study the different growth regulating compounds on morphological, quality and yield parameters in greengram at Acharya N.G Ranga Agricultural University, Hyderabad during *rabi* 2009-10. The basic material for the present investigation consists of Greengram cv WGG-37 and two growth promoting (NAA and Brassinosteroid) and growth retarding substances (Chlormequat chloride and Mepiquat chloride). These growth regulators were sprayed at flower initiation stage. The morphological traits viz., plant height, number of branches per plant, number of trifoliates per plant and days to 50% flowering and maturity were significantly increased by NAA @ 20 ppm, whereas total dry matter production (TDM) over growth regulator treatments at all stages NAA (20 ppm) and brassinosteroid (20ppm) recorded significantly higher values. Among the quality parameters highest seed protein content (%) and highest nitrogen harvest index values were recorded with growth retarding substance chlormequat chloride (187.5 g a.i ha^{-1}) in greengram. The seed yield increased significantly with NAA (20 ppm) followed by mepiquat chloride 5% AS, brassinosteroid (20 ppm), chlormequat chloride (137.5.5 a.i/ha).

Key words: Greengram, Plant growth regulators, Morphological, Quality characters, Yield.

INTRODUCTION

Flower and pod shedding is a common problem in green gram (Mungbean). There is also a possibility to overcome these constraints by foliar application of plant growth regulators at the pre-flowering stage, which is one of the latest trends in agriculture. These plant growth regulators (PGRs) in general, help to increase the number of flowers on the plant when applied at the time of flowering. The flower and pod drop may be reduced to some extent by spraying various growth regulators on foliage (Ramesh and Thirumuguran, 2001). The plant growth regulators play an important role in overcoming the hurdles in manifestation of biological productivity in pulses. The use of plant growth regulators are known to improve the physiological efficiency including photosynthetic ability of plants and offer a significant role in realizing higher crop yields (Murthy and Singh 1983). The PGRs are also known to enhance the source-sink relationship and stimulate the translocation of photo-assimilates, thereby increasing the productivity. Use of these regulators should be judicious in any given cropping system (Taiz and Zeiger, 2003). Upadhaya (1994) reported that foliar spray of NAA at bud initiation and pod formation stage of chick pea increased plant height, number of branches, number of flower buds, number of flowers and yield. The main role of NAA rests with the efficient transport of sugars from the photosynthesizing parts of the plant (source) to the developing grains (sinks) and also facilitating nitrogen accumulation that probably resulted in higher total dry matter production (Kalita *et al., 1995*). Foliar spray of 25 ppm NAA recorded significantly higher seed yield by 21 to 22 per cent over control through increased flower production, clusters per plant, pod setting percentage and pods per plant in mungbean (Patil *et al.*, 2005). Hence, the present work is carried out to study the effect of certain growth promoting and retarding compounds on morphological, quality and yield parameters in green gram.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* 2009-2010 at Student's Farm, College of Agriculture, Acharya N.G. Ranga Agricultural University, Hyderabad. The experiment was laid out in randomized block design using the cv. WGG-37 with nine treatments viz, chlormequat chloride 50% SL (137.5 g a.i ha^{-1},162.5 g a.i ha^{-1}, 187.5 g a.i $ha^{-1}$and 375.0 g a.i ha^{-1}), Mepiquat chloride 5% AS, NAA (20 ppm), Brassinosteroid (20 ppm), Water spray and Control replicated thrice. Growth regulators were sprayed on 38 DAS (Initiation of flowering).

Plants in one m^2 area were tagged separately. These were used to measure the plant height from the cotyledonary node up to the growing tip and the mean of five plants selected at random in each treatment, the number of branches per plant was counted at each sampling and mean values of five plants was expressed. Total numbers of trifoliates was determined by counting the leaves from top to bottom of the plant and the mean value of the five plants taken from in each treatment was expressed on per plant basis. Five adjacent plants in an m^2 area other than border ones were sampled from each treatment were dug out carefully at 30, 45, 60 and 75 DAS and they were brought to the laboratory and separated into different component parts and dried in hot-air oven at 60^0-70^0C till constant weight in obtained. The dried samples were weighed to record data on dry matter production. The seed and plant material was dried and powdered. Thereafter the nitrogen percentage in the seed was estimated by taking 0.1 g of powdered seed sample following the micro kjeldhal procedure as given in AOAC (1980). The protein percentage was estimated by multiplying the nitrogen percentage with a factor 6.25. Nitrogen harvest index as calculated by using the following formula.

$$\text{Nitrogen harvest index} = \frac{\text{Total Protein content in seed}}{\text{Total protein content in plant}} \times 100$$

Already tagged plants from each treatment were harvested at maturity to record data on yield attributes i.e., number of pods per plant, number of seeds per pod, number of seeds per plant and test weight. After threshing, cleaning and drying, seed yield from one m^2 area from each treatment was recorded and the data were used to express the seed yield on hectare basis. The data were analyzed statistically following the method given by Panse and Sukhatme (1989) and wherever the results were significant, the critical difference (CD) was calculated at 5 per cent level of significance (P=0.05).

RESULTS AND DISCUSSION

Plant growth regulators are organic substances which in minute quantities increase or decrease or modify the physiological processes in plants which are finally expressed in the form of growth and development (Taiz and Zeiger, 2003). Plant growth regulators are also known to play a positive role in enhancing qualitative and quantitative characters in plants.

Morphological characters

The data on plant height at different growth stages indicated that plant height was maximum at 75 DAS and sustained thereafter (Table 1). At 75 DAS chlormequat chloride (187.5 a.i/ha) treated plants recorded significantly higher plant height (50.23 cm) compared to control (43.15 cm). The mechanism of reduction in plant height appears to be due to retardation of transverse cell division particularly in steelar cambium, which is the zone of meristematic activity at the base of internode (Grossman, 1990). Jayaramireddy *et al.* (2004) reported increased plant height with NAA @ 10 ppm in black gram. Similarly, Senthil Kumar and Jayakumar (2004) revealed that NAA spray recorded maximum plant height in green gram. Radhika (2005) observed that foliar application of NAA @ 20 ppm increased plant height in chickpea. In general, leaf is considered as an important functional unit of plant which contributes to the formation of yield. The number of trifoliate leaves increased gradually from 30 to 60 DAS, and thereafter declined due to senescence (Table 1). Among the treatments maximum number of trifoliates per plant was recorded by NAA (20 ppm) (11.3), while the minimum was recorded in control (4.3). It was also recorded that the number of trifoliates had a significant positive association with seed yield. Similar results were reported by Chandrababu, 1990, Shinde and Jadhav (1995) in mungbean and cowpea respectively. The number of branches per plant increased from 30 to 75 DAS (Table 1). Application of NAA @ 20 ppm recorded (6.9) significantly higher number of branches per plant followed by chlormequat chloride (162.5 a.i./ha) (6.8) and chlormequat chloride (187.5 a.i./ha) (6.7) over the control. The number of branches, an important morphological character is directly related to yield in soybean (Knoienczny *et al.,* 1994). Similar results were reported by Radhika (2005) that NAA @ 20 ppm increased the number of branches in chickpea.

The total dry matter production of growth regulator treatments (Table 2 and Fig.1) indicated that there was an increase in dry weight of total dry matter with increase in time up to harvest. This could be due to the translocation of stored photo assimilates towards the development of reproductive organs. The application of growth regulator treatments had a positive effect on total dry weight. It was more in NAA (20 ppm) (531.93 g m^{-2}) followed by brassinosteroid (20ppm) (524.82 g m^{-2}) over control. The distribution of dry matter formed among various plant organs is a major determinant for both total dry matter production and economic yield and amount of total dry matter produced as an indication of overall efficiency of utilization of resources and better light interception. Patel and Saxena (1994) and Lakshmamma and Rao (1996) also reported increased dry matter production due to the application of NAA in blackgram. Combination of N-tricontanol with planofix also increased the dry matter accumulation in soybean (Shukla *et al.,* 1997).

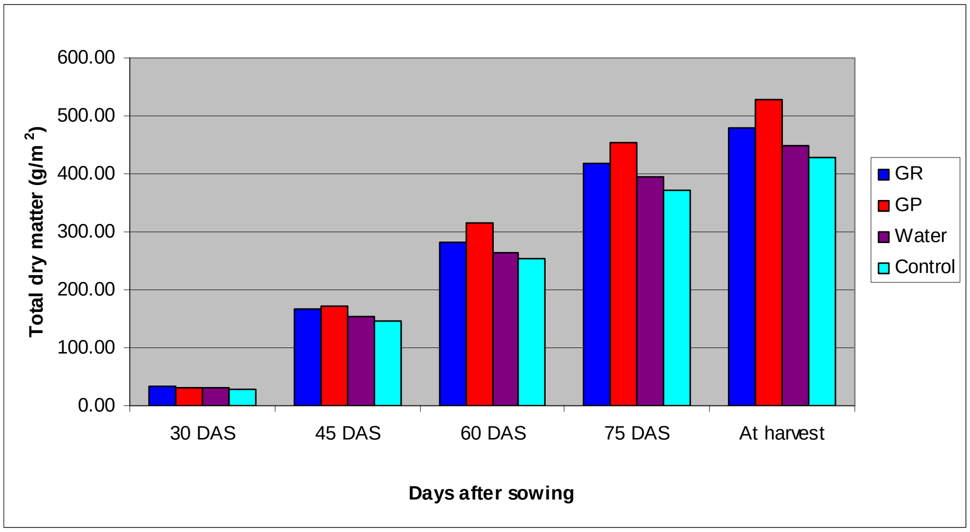


Figure 1: Total dry matter production at different stages due to growth regulators in green gram

The results revealed that, there was no significant difference for days taken for 50% flowering and maturity (Table 3). The growth retardant treatment chlormequat chloride (375.0 and 187.5 a.i./ha) recorded more number of days to 50% flowering (43) compared to control. Mepiquat chloride (5% AS) recorded more number of days to maturity (84) followed by chlormequat chloride (187.5 a.i./ha), chlormequat chloride (375.0 a.i./ha) and brassinosteroid (20 ppm) (83). This suggested that these parameters are mainly under genetic control.

Table 1. Effect of different growth promoting and retarding substances on number of plant height (cm), trifoliates/plant an branches/plant in green gram

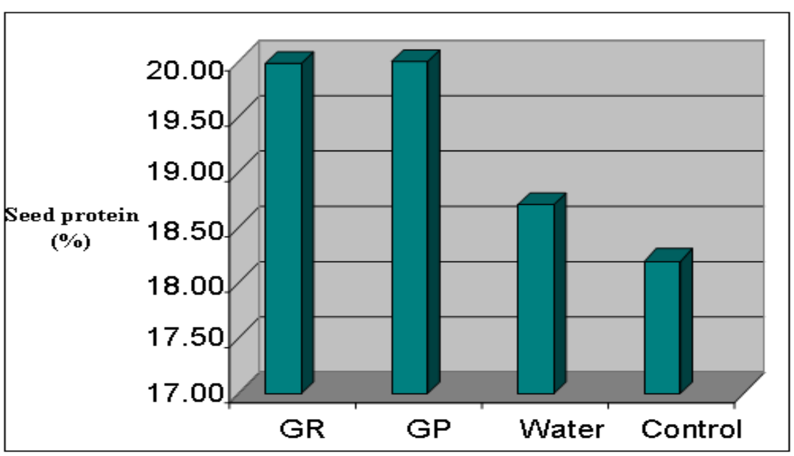
Treatments	Plant height (cm)					No. of trifoliates/plant					No. of branches/plant				
	30 DAS	45 DAS	65 DAS	75 DAS	harvest	30 DAS	45 DAS	65 DAS	75 DAS	harvest	30 DAS	45 DAS	65 DAS	75 DAS	harvest
Chlormequat Chloride 50% SL (137.5 a.i/ha)	9.90	31.46	43.11	49.93	49.93	5.5	7.9	8.3	6.4	4.9	2.6	4.7	5.6	6.6	6.6
Chlormequat Chloride 50% SL (162.5 a.i/ha)	10.03	30.06	43.56	44.33	44.33	5.5	7.4	8.4	6.7	5.3	2.8	4.9	5.8	6.8	6.8
Chlormequat Chloride 50% SL (187.5 a.i/ha)	10.03	31.56	42.93	50.23	50.23	5.4	8.0	8.4	6.1	5.6	2.7	4.8	5.7	6.7	6.7
Chlormequat Chloride 50% SL (375 a.i/ha)	9.03	32.13	40.28	45.26	45.26	5.3	8.1	8.6	6.8	5.3	2.5	4.7	5.5	6.5	6.5
Alpha naphthyl acetic acid (NAA) (20 ppm)	8.90	31.63	42.76	45.30	45.30	4.5	7.9	11.3	8.4	5.5	3.0	5.0	5.9	6.9	6.9
Mepiquat Chloride 5%AS (5%)	8.93	31.33	42.46	45.80	45.80	4.3	8.0	9.0	7.1	6.7	2.7	4.8	5.6	6.6	6.6
Brassinosteroid (20 ppm)	9.95	29.63	41.85	47.43	47.43	5.2	8.0	9.0	6.0	5.6	2.1	4.6	5.5	6.5	6.5
Water	9.43	30.56	40.66	45.74	45.74	4.5	8.1	9.2	5.6	4.6	2.1	4.6	5.5	6.4	6.4
Control	9.68	30.43	40.43	43.15	43.15	4.8	7.4	8.3	5.3	4.3	2.0	4.0	4.6	5.7	5.7
Mean	9.52	30.98	42.02	46.28	46.28	5.0	7.9	8.9	6.5	5.3	2.7	4.6	5.5	6.5	6.5
SEd	0.58	1.49	2.57	2.09	2.09	0.2	0.8	1.1	0.5	0.9	0.1	0.1	0.1	0.1	0.1
CD 5%	NS	NS	NS	4.44	4.44	0.6	1.7	NS	1.2	NS	NS	0.3	0.3	0.2	0.2

Quality parameters

The application of growth regulators showed significant effect on protein content in seed (Table 4 and Fig.2). Among the treatments Chlormequat chloride (187.5 g a.i./ha) recorded significantly higher seed protein content (20.63 %) followed by mepiquat chloride 5% AS and chlormequat chloride @ 162.5 g a.i./ha with 20.27 and 20.17% respectively. All growth regulator treatments did not show any significant effect on nitrogen harvest index. Though there were significant differences for total protein content in plant and seeds, nitrogen harvest index did not differ significantly (Table 4). Highest protein content values of 0.9 g in seeds and 5.44 g in plant were recorded with NAA 20ppm. However, the nitrogen harvest index was low in control (15.62) and more in chlormequat chloride @ 187.5 g a.i ha^{-1} (17.31). The maximum seed protein percentage (20.63) and nitrogen harvest index (17.31) was recorded in chlormequat chloride (187.5 g a.i/ha). The higher uptake as well as mobilization of nitrogen might have resulted in enhanced synthesis of amino acids and thereby higher protein content in seeds. Senthil kumar and Jaya kumar (2004) reported that nitrogen and protein contents were increased in seed with NAA @ 10 ppm in green gram.

Table 2. Effect of different growth promoting and retarding substances on total dry weight (g/m^2) in Green gram

Treatments	30 DAS	45 DAS	60 DAS	75 DAS	Harvest
Chlormequat Chloride 50% SL (137.5 a.i/ha)	36.56	161.78	274.25	420.79	485.38
Chlormequat Chloride 50% SL (162.5 a.i/ha)	32.48	169.46	287.87	413.32	453.27
Chlormequat Chloride 50% SL (187.5 a.i/ha)	36.45	164.95	296.35	401.20	492.93
Chlormequat Chloride 50% SL (375 a.i/ha)	34.02	156.42	256.90	389.97	450.94
Alpha naphthyl acetic acid (NAA) (20 ppm)	30.54	174.21	320.92	435.65	531.93
Mepiquat Chloride 5% AS (5%)	31.58	185.90	289.58	459.66	510.05
Brassinosteroid (20 ppm)	28.80	167.80	308.75	473.02	524.82
Water	29.88	153.14	265.24	394.02	448.62
Control	28.68	146.08	254.34	372.86	427.05
Mean	32.23	163.81	283.83	417.66	480.55
SEd	1.84	19.87	16.02	16.15	21.09
CD 5%	3.91	NS	36.95	37.24	47.71



GP = Growth promoters **GR** = Growth retardant

Figure 2: Effect of growth regulators on seed protein (%) in green gram

Yield and yield components

The growth regulators are capable of redistribution of dry matter in the plant and there by bringing about an improvement in yield potential. Among the treatments highest seed yield of 1310 kg ha^{-1} was recorded in NAA 20 ppm followed by mepiquat chloride (5% AS) and brassinosteroid (20 ppm) with a yield of 1272 and 1234 kg ha^{-1} respectively.

Table 3. Effect of different growth promoting and retarding substances on phonological stages in green gram.

Treatments	Days to 50% Flowering	Days to Maturity
Chlormequat Chloride 50% SL (137.5 a.i/ha)	42	82
Chlormequat Chloride 50% SL (162.5 a.i/ha)	42	82
Chlormequat Chloride 50% SL (187.5 a.i/ha)	43	83
Chlormequat Chloride 50% SL (375 a.i/ha)	43	83
Alpha naphthyl acetic acid (NAA) (20 ppm)	42	82
Mepiquat Chloride 5% AS (5%)	41	84
Brassinosteroid (20 ppm)	42	83
Water	41	79
Control	40	78
Mean	42.0	82.0
SEd	1.5	2.4
CD 5%	NS	NS

Table 4. Effect of different growth promoting and retarding substances on Nitrogen harvest index in green gram

Treatments	Total protein content in seed (g plant^{-1})	Seed protein (%)	Total protein content in plant (g plant^{-1})	Nitrogen Harvest Index
Chlormequat Chloride 50% SL (137.5 g a.i/ha)	0.82	19.70	4.60	17.20
Chlormequat Chloride 50% SL (162.5 g a.i/ha)	0.85	20.17	5.01	17.06
Chlormequat Chloride 50% SL (187.5 g a.i/ha)	0.80	20.63	4.80	17.31
Chlormequat Chloride 50% SL (375 g a.i/ha)	0.84	19.20	4.92	16.49
Alpha naphthyl acetic acid (NAA) (20 ppm)	0.90	20.00	5.44	16.78
Mepiquat Chloride 5% AS (5%)	0.77	20.27	4.36	17.05
Brassinosteroid (20 ppm)	0.84	19.80	5.20	16.66
Water	0.66	18.70	4.05	16.44
Control	0.52	18.20	3.85	15.62
Mean	0.77	19.62	4.69	16.73
SEd	0.44	0.14	0.87	1.26
CD (P=0.05)	0.12	0.31	0.33	NS

The highest seed yield with NAA 20 ppm application can be attributed to more value for the number of pods per plant (25.1), seeds per pod (7.0) and test weight (37.1 g) as compared to other treatments (Table 5). Similar results were reported that significantly influenced by the application of NAA in mungbean (Patil *et al.*, 2005). Though there was significant difference among the treatments for grain yield, no significant difference was observed in harvest index indicating that the increase in the yield was due to increase in the total dry matter rather than harvest index.

Table 5. Effect of different growth promoting and retarding substances on yield and yield attributes in green gram.

Treatments	Pods per Plant	Seeds per Pod	Seeds per Plant	Test weight (g)	Yield kg/ha	HI
Chlormequat Chloride 50% SL (137.5 a.i/ha)	21.9	6.0	128.6	35.1	1208.64	36.71
Chlormequat Chloride 50% SL (162.5 a.i/ha)	21.5	6.8	143.4	32.2	1081.42	36.23
Chlormequat Chloride 50% SL (187.5 a.i/ha)	23.9	6.5	155.6	35.6	1094.14	36.90
Chlormequat Chloride 50% SL (375 a.i/ha)	21.9	6.1	133.6	32.3	1170.47	34.77
Alpha naphthyl acetic acid (NAA) (20 ppm)	25.1	7.0	176.9	37.1	1310.42	34.93
Mepiquat Chloride 5% AS (5%)	21.3	6.6	137.9	35.1	1272.26	36.94
Brassinosteroid (20 ppm)	20.4	6.9	138.2	32.5	1234.09	34.59
Water	19.8	5.9	115.4	31.8	1094.14	33.63
Control	19.4	5.7	109.5	31.4	1106.86	32.48
Mean	21.7	6.3	137.8	33.7	1174.71	35.24
SEd	2.8	1.1	19.9	0.2	104.46	5.12
CD 5%	6.8	2.6	NS	0.3	221.45	NS

CONCLUSION

The growth regulator treatments showed profound effect on morphological characters like number of branches and the number of trifoliates per plant were significantly increased by NAA @ 20 ppm, whereas plant height was significantly increased by chlormequat chloride 50% SL (187.5 a.i/ha) over control. The treatments with NAA (20 ppm) recorded significantly higher values for total dry matter production. Among the quality parameters highest seed protein content (%) and highest nitrogen harvest index values were recorded with growth retarding substance chlormequat chloride (187.5 g a.i ha^{-1}) in greengram. The seed yield increased significantly with NAA (20 ppm) followed by mepiquat chloride 5% AS.

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