Journal of Medicinal Plants Studies
www.PlantsJournal.com

ISSN 2320-3862
JMPS 2016; 4(6): 162-166

Received: 21-09-2016
Accepted: 22-10-2016

M P Semwal
Ph.D. Scholar,
Dept. of Agronomy,
College of Agriculture,
G.B. Pant University of Agriculture & Technology, Pantnagar,
Uttarakhand, India

Sunita T Pandey
Professors College of Agriculture,
G.B. Pant University of Agriculture & Technology, Pantnagar,
Uttarakhand, India

V Pratap Singh
Professors,
Dept. of Agronomy,
College of Agriculture,
G.B. Pant University of Agriculture & Technology, Pantnagar,
Uttarakhand, India

Ajit Kumar
Assistant Professors,
Dept. of Horticulture,
College of Agriculture,
G.B. Pant University of Agriculture & Technology, Pantnagar,
Uttarakhand, India

Poonam Gautam
Assistant Professors,
Dept. of Soil Science,
College of Agriculture,
G.B. Pant University of Agriculture & Technology, Pantnagar,
Uttarakhand, India

Sumit Chaudhary
Ph.D. Scholar,
Dept. of Agronomy,
College of Agriculture,
G.B. Pant University of Agriculture & Technology, Pantnagar,
Uttarakhand, India

Digendra Singh
Ph.D. Scholar,
Dept. of Horticulture,
College of Agriculture,
G.B. Pant University of Agriculture & Technology, Pantnagar,
Uttarakhand, India

Correspondence
M P Semwal
Ph.D. Scholar,
Dept. of Agronomy,
College of Agriculture,
G.B. Pant University of Agriculture & Technology,
Pantnagar, Uttarakhand, India

Influence of planting geometries and weed control practices on growth and herbage yield of *Kalmegh* (*Andrographis paniculata* Nees.)

MP Semwal, Sunita T Pandey, V Pratap Singh, Ajit Kumar, Poonam Gautam, Sumit Chaudhary and Digendra Singh

Abstract
Field experiments was conducted during *Kharif* season of 2014 and 2015 at MRDC of G.B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand), India to study the effect of planting geometries and weed control practices on growth and herbage yield of *Kalmegh* (*Andrographis paniculata* Nees.). The findings of the study indicated that *kalmegh* growth related parameters like number of branches, plant spread and leaf area index were significantly influenced by the wider planting geometry over that of closure during both the years. However, plant height, dry matter accumulation by crop/m^2 and dry hectare herbage yield/ha were significantly influenced under the closing planting geometry as compared to wider during both the years. It was also observed that keeping weed free condition aside, the integration of weed management practices like application of pendimethalin 30 E.C PE.@1.0 kg *a.i.*/ha + quizalofop ethyl 5 E.C. PoE @ 50 g *a.i.*/ha at 3-5 leaves stage of weeds followed by mechanical weeding by hand hoe at 30-35 DAT and pendimethalin 30 E.C. PE @1.0 kg *a.i.*/ha followed by mechanical weeding by hand hoe at 30-35 DAT proved effective in producing more plant height, number of branches, plant spread, leaf area index, dry matter accumulation by crop/m^2 and dry herbage yield/ha as compare to remaining treatments during both the years. The results also revealed that the interaction effects of these treatments with respect to dry herbage yield/ha were also found significantly during both the years. Therefore, based on the above two years findings it is concluded that an integrated approach of pre and post-emergence applied herbicides followed by mechanical weeding along with closured plating geometry produced the best result to achieving more dry herbage yield of *kalmegh*.

Keywords: Herbage yield, *kalmegh* (*Andrographis paniculata* Nees.), planting geometry, pendimethalin, quizalofop ethyl and weed control

1. Introduction

India, with its diverse agro-climatic conditions and regional topography has been considered as the treasure house of plant genetic resources. It is recognized as one of the world's top 12 mega biodiversity centers of the world. Our herbal wealth constitutes more than 8,000 species and accounts for around 50% of all higher flowering plant species of India. However, available information shows that only 1,800 species are used in classical Indian Systems of Medicines. Herbal medicines are still the mainstream of the majority of the world population, mainly in the developing countries for primary health care because of better cultural acceptability, compatibility within the human body and lesser side effects. At present, 80 per cent of the population in developing countries relies largely on plant-based drugs for their health care needs, and the FAO has estimated that the trend in the world population may remain similar that rely on plant-based medicines in coming decades (FAO, 1997) [2]. The annual demand of botanical raw drugs in the country was estimated at 3, 19,500 MT at a cost of Rs. 1,069 crores for the year 2005-06 (Upadhyay *et al.*, 2011) [14]. Today, MAPs are finding diverse use in the society from medicine to cosmetics and herbal drinks to herbal foods in the daily uses. Herbs play a significant role, especially in modern times. The valuable medicinal effects of plant materials typically result from the combinations of secondary metabolites such as alkaloids, steroids, tannins, phenolic compounds, flavonoids, resins, fatty acids, gums, *etc*. (Saikia 2013 and Okwu, 2001) [10, 6]. The herbaceous plant *Kalmegh* (*Andrographis paniculata* Nees.), is an important plant species in the family of Acanthacese, which is one of the most important medicinal plant species which is recommended for cultivation on account of its great demand by the pharmaceutical industries.

The plant is known in north eastern India as *Maha-tita*, literally "king of bitters", and known by various vernacular names. It is used in Indian Systems of Traditional Medicine for malaria, typhoid, itching, diabetes, dehydration, etc. It has also been reported as having antibacterial, antifungal, antiviral, choleretic, hypoglycemic, hypocholesterolemic, and adaptogenic effects. In the Unani System of Medicine, it is considered aperients, anti-inflammatory, emollient, astringent, diuretic, emmenagogue, gastric, liver tonic, carminative, anthelmintic and antipyretic. The whole herb is the source of several diterpenoids of which the bitter, water soluble lactone andrographolide is important which is distributed all over the plant body in different proportions. In *Kalmegh,* though satisfactory research work is going on *viz.,* nutrient management (Ram *et al.,* 2008 and Sanjutha *et al.,* 2008) [7, 11], planting geometry (Singh *et al.,* 2011 and Krishna *et al.,* 2014) [8, 4], water management (Singh, 1996) [9], and suitable genotype (Bhan *et al.,* 2006) [1] by many researches and scientists at different places of the country but very little or meager work has been carried out on the weed management. Aspects being a *Kharif* season crop weeds have intensive competition with the *kalmegh* crop for nutrient, light, space, moisture and temperature, which ultimately causes a huge reduction in the yield, yield contributing character and quality of medicinal plants, and it also reduces the efficiency of farm resources which is the major constraint for the cultivation of *kalmegh* crop. Among all the different agro-techniques required to increase the production of *Kalmegh,* timely weed control practices in relation to optimum planting geometry to ensure adequate plant stand has emerged as one of the major constraints of production. In recent years, due to heavy infestation of weeds, increased labour cost and non-availability of labours for weeding at peak periods, the use of herbicides has become indispensable. Crop geometry is very important and the primary information required for cultivation of any crop especially in relation to weeds management, for getting an optimum plant stand as well as to reduce the crop-weeds competition and over all increased crop quality and production through efficient utilization of natural resources and input available. The information available on weed management with respect to its cropping geometry especially through pre and post-emergence application of herbicides in *Kalmegh* in India and abroad more especially in northern India is meagre and scanty. Moreover, the production technology of *Andrographis paniculata* has not yet been standardized, especially on weeds management with respect to cite specific cropping geometry. Therefore, keeping these facts in mind, the present study was carried out to find out optimum planting geometry and weed management practice in *kalmegh* under *tara*i conditions of Uttarakhand.

2. Materials and methods

The present experiment was carried out at Medicinal and Aromatic Research and Development Centre (MRDC) of G.B. Pant University of Agriculture & Technology, Pantnagar, U.S. Nagar (Uttarakhand), India during *kharif* season of 2014 and 2015. The soil of the experiment plot was sandy clay loam in texture having high organic carbon (0.78 & 0.82% and 0.84 & 0.86%), low in available nitrogen (181.57 & 191.30 and 185.65 & 195.69 kg/ha), high in available phosphorus (32.01 & 36.93 and 35.29 & 41.04 kg/ha) and medium in exchangeable potassium (223.54 & 240.86 and 235.08 & 250.09 kg/ha) contents with slightly alkaline in reaction (pH 7.29 & 6.74 and 6.96 & 7.23) before transplanting and after harvesting during both the years, respectively. The experiment, treatments comprising of three planting geometries (P_1 = 30 cm × 20 cm, P_2 = 40 cm × 25 cm and P_3 = 50 cm × 30 cm) and six level of weed control practices (W_1 = Pendimethalin 30 E.C. PE @1 kg *a.i.*/ha followed by mechanical weeding by hand hoe at 30-35 DAT, W_2 = Quizalofop ethyl 5 E.C. PoE @ 50 g *a.i.*/ha at 3-5 leaves stage of weeds followed by mechanical weeding by hand hoe at 30-35 DAT, W_3 = Pendimethalin 30 E.C. PE @1 kg *a.i.*/ha + Quizalofop ethyl 5 E.C. PoE @ 50 g *a.i.*/ha at 3-5 leaves stage of weeds, W_4 = Pendimethalin 30 E.C. PE @1 kg *a.i.*/ha + Quizalofop ethyl 5 E.C. PoE @ 50 g *a.i.*/ha at 3-5 leaves stage of weeds followed by mechanical weeding by hand hoe at 30-35 DAT, W_5 = Weedy check and W_6 = Weed free) were laid out in split plot design keeping planting geometries in main plots and weed control practices in sub plots with three replications. Kalmegh, variety SIM-Megha, was sown in the nursery on May 16, and May 22, during 2014 and 2015, respectively and Transplanted on July 16, and July 02, during both the years, respectively and harvested on 20th Oct. and 7th Oct. during 2014 and 2015. Observations with respect to growth, yield and chemical attributes were recorded. The standard method of analysis of variance technique appropriate to the split plot design as described by (Gomez and Gomez 2010) was used.

3. Result and discussion

Plant height at 90 DAT (at harvest) stage (Table 1) of crop was not significantly influenced by different planting geometries during both the years. However, maximum plant height was observed with 30 cm × 20 cm. Among the different weed control practices, weed free conditions resulted significantly taller plant than W_1 and W_2 during both years but remained at par with W_5 (weedy check), W_4 and W_3 during 2014-15, and with W_5 (weedy check) and W_4 during 2015-16. Among herbicides treatments, significant increased in plant height was observed under all the herbicidal treatments during both the years, except under W_2 which were failed to produce taller plants during both years. The more plant height under narrow planting geometry, weed free and weedy check treatments might be attributed due to the reason that the denser plant stand, leads to more competitions for the radiation to rescue the photosynthetic demand of plant that may be a major reason of the upward creeping stem and stem elongation behaviour of kalmegh plant along up with weeds which help them to increased plant heights as was observed by the author during experimentation in the field under denser planting geometry, weed free and weedy check conditions as compared to other treatments.

The differences in number of branches due to different planting geometries and weed control practices were influenced significantly at harvest during both the years (Table 1). Planting geometries, P_3 (50 cm × 30 cm) resulted significantly more number of branches than all the other planting geometries during both the years. The reason might be due to the fact that availability of more space and resources in wider spacing which leads to more number of branches/plant. Wider rows and modifying crop geometry can help to suppress intra plant pacing weeds through rapid canopy closure and increased fruiting of more lateral branches. Numbers of branches at harvest were significantly influenced by weed control practices. Weed free conditions produce significantly higher number of branches than all the other weed control practices during both the years. Weedy check treatments caused significantly lowest number of branches than all the other weed control practices during both the years but remained at par with W_3 only during 2014. Among herbicides treatments, W_4 increased significantly higher number of branches than all the other herbicides treatments during both years, whereas W_1 and W_2 remained at par with each other only during 2014. The results revealed that weeding had direct effect to increase the number of branches. With decreasing weed population, number of branches/plant increased, because of higher absorption of nutrient and water from soil. As a result, activity of cell increased. This favoured more vegetative growth and produced higher number of branches. The lower number of branches in weedy check and W_3 might be attributed to severe competition exerted by weeds for the available resources throughout the crop period which lowered the number of branches under these treatments. Similar result was also reported by (Kumar *et al.,* 2010) [5].

Different planting geometries had a significant influence on plant spread of *kalmegh* at harvest (Table 1). Planting geometries of 50 cm × 30 cm produced significantly wider plant spread than that of all the other planting geometries during both the years. Plant spread due to weed control practices was also influenced significantly. Weed free conditions caused significantly wide plant spread than all the other weed control practices during both the years. Whereas as weedy check conditions caused significant reduction in plant as compared to rest of the other weed control practices during both the years. Among the herbicides treatments W_4, produced significantly higher plant spread than all the other herbicides treatments during both the years. Lateral extension of uppermost leaves and branches may reduce light received by neighbors, but that light may be intercepted by the larger plant at intensities in excess of the light saturation point of the photosynthesis curve. An increase in the angles of these leaves and branches, and reduction in their size, may reduce total light intercepted but not necessarily the total amount of whole-plant photosynthesis since uppermost leaves may still receive light close to the light saturation point of photosynthesis for considerable periods and more light will reach lower, more shaded, foliage. Reduced exposure of foliage to high irradiance may reduce the possibility of photo-damage and high evaporative demand on the foliage.

Planting geometry, P3 (50 cm × 30 cm) caused significantly higher LAI than all the other planting geometries at harvest during both the years (Table 1). Leaf area index due to weed management practices was influenced significantly during both the years. Weed free conditions caused significantly higher LAI than all the other weed management practices during both years. Similarly weedy conditions caused significant reduction in LAI than all the other weed management practices during both the years. However, among the herbicides treatments, W_4 produced significantly highest LAI than all the other herbicides treatments during both years. Increased in the leaf area, which facilitates better utilization of solar radiation for the synthesis of primary and secondary metabolites, might be due to vigorous plant growth. As light captured by leaf area is more crucial in enhancing leaf area thickness and dry matter accumulation by crop. Leaf area determined light interception and is an important parameter in determining plant growth. In addition high output phenolotype of plants often realize on optical methods with altered photosynthetic rates because they are non-destructive and cost effective (Zang *et al.,* 2012 and Tessmer *et al.,* 2013) [15, 13].

The planting geometry of P_3 (50 cm × 30 cm) produced significantly higher dry matter accumulation by crop compared to remaining planting geometries at harvest during both the years (Table 1). Among the weed management practices, weed free conditions resulted in significantly more dry matter accumulation by crop compared to remaining weed control practices during 2015, but remained at par with W_4 during 2014. Weed control practice, W_5 (weedy check) and W_3 remained at par with each other but caused significantly less dry matter accumulation by crop compared to remaining treatments during 2015-16, but caused significantly higher dry matter accumulation by than all the other weed management crop during both the years. Among herbicides treatments, W_4, W_1 and W_2 caused similar dry matter accumulation by crop but significantly more than W_3 during 2014, while during 2015, W_4, being at par with W1 caused significantly higher dry matter accumulation by crop compared to W_2 and W_3. High dry matter accumulation may be due to more number of plants/unit area and less weeds density under narrow planting geometry (Table 1) and hence more dense population of *kalmegh* plant in closer spacing which resulted in more total dry matter accumulation. Sharif *et al.,* (2014) [12] reported that plots treated with both pre and post-emergence herbicides always has less total weed density and more crop biomass than those that were treated with only pre-emergence herbicides.

Dry herbage yield was significantly higher under P_1 (30 × 20 cm) as compared to the other planting geometries during both years. Significantly higher herbage yield was recorded under narrow row spacing (Table 1). The increase in yield with narrow row spacing might due to less competition between plants with more equidistant spatial arrangement. Moreover, this may reduce the competition of weeds for light, nutrients and other resources. Therefore, reducing the distance between rows increased radiation interception and source-sink relationship that ultimately increased herbage yield. Weed control practices caused significantly higher dry herbage yield under weed free conditions compared to remaining weed control practices during both the years. Weedy conditions caused significant reduction in dry herbage yield than all the other weed control practices during both the years. Among herbicide treatments W_4 increased significantly maximum dry herbage yield than all the other herbicide treatments but remained statistically at par with W_1 during both the years.

The interactions between planting geometries and weed control practices with respect to dry herbage yield were found significant during both the years (Table 2). Weed free treatment under all the planting geometries influenced significantly higher dry herbage yield over that of the remaining weed control treatments during both the years. The weedy check and W_3 treatments being statistically at par caused similar dry herbage yield under all the planting geometries, but significantly less than the remaining treatments during both the years. Among herbicides treatments, W_4, being at par with W_1 increased significantly higher dry herbage yield under all the planting geometries than rest of the other herbicides treatments during both the years. However, under P_1 planting geometry W_1 and W_2 remained at par with each other during 2015. Under W_1, W_2, W_4 and W_6 (weed free) treatments the dry herbage yield due to various weed control practices increased significantly higher with increased in planting geometries during both the years, Under W_3 and W_5 (weedy check) the dry herbage yield due to P_1 planting geometry being at par with P_2, increased significantly higher dry herbage yield than P_3, however, P_2 and P_3 remained statistically on a par with each other during both the years. Keeping weed free aside, W_4 treatment being at par with W_2 under P_1 planting geometry recorded significantly higher dry herbage yield as compared to all the other combinations during both the years.

Table 1: Effect of various planting geometry and weed control practices on different crop growth parameters and dry herbage yield of *kalmegh* during 2014 and 2015.

Treatment	Plant height (cm/plant)		No. of branches/plant		Plant spread/plant (cm)		Leaf Area Index		Dry matter accumulation by crop/m^2		Dry herbage yield (q/ ha)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Planting geometries												
P_1 (30 cm × 20 cm)	65.0	67.8	68.8	37.4	37.4	44.3	2.28	2.34	625.74	667.82	29.2	31.7
P_2 (40 cm × 25 cm)	61.9	65.9	71.0	41.5	41.5	47.1	2.41	2.46	375.44	424.66	22.0	23.9
P_3 (50 cm × 30 cm)	61.6	63.6	74.9	44.0	44.0	50.1	2.49	2.52	250.30	314.89	16.2	18.0
± SEM	0.9	0.9	0.5	0.3	0.3	0.6	0.02	0.01	8.83	5.47	0.7	0.7
CD (5%)	NS	NS	2.0	1.2	1.2	2.3	0.06	0.04	34.51	21.39	2.8	2.6
Weed management practices												
W_1	61.1	64.6	74.3	44.5	44.5	54.1	2.44	2.49	484.44	536.64	26.7	28.8
W_2	58.6	62.5	71.0	39.4	39.4	50.9	2.36	2.41	465.56	513.54	21.5	23.5
W_3	62.3	65.3	55.7	35.4	35.4	34.3	2.30	2.33	289.26	298.20	11.1	13.2
W_4	63.6	66.3	82.9	45.3	45.3	55.7	2.48	2.53	491.85	557.26	27.8	29.9
W_5	65.2	67.2	54.5	30.5	30.5	29.3	2.25	2.29	250.74	290.28	9.1	10.5
W_6	66.1	68.7	91.0	50.8	50.8	58.9	2.53	2.59	521.11	618.81	38.5	41.1
± SEM	1.4	1.1	1.3	0.7	0.7	0.8	0.01	0.01	11.73	7.41	0.5	0.6
CD (5%)	3.9	3.1	3.7	1.9	1.9	2.2	0.02	0.01	33.88	21.41	1.4	1.7

Table 2: Interaction between weed control practices and planting geometries with respect to dry herbage yield during 2014 and 2015.

Weed Control Practices	Dry herbage yield (q/ ha)							
	2014				2015			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
W_1	32.6	26.9	20.6	26.7	37.0	28.9	20.4	28.8
W_2	30.0	20.0	14.4	21.5	29.2	22.7	18.6	23.5
W_3	14.1	10.6	8.8	11.1	16.6	12.9	10.3	13.3
W_4	34.7	28.1	20.5	27.8	38.0	29.5	22.3	29.9
W_5	11.9	8.8	6.6	9.1	13.4	10.1	8.0	10.5
W_6	51.9	37.5	26.3	38.5	55.8	39.1	28.4	41.1
Mean	29.2	22.0	16.2	22.4	31.7	23.9	18.0	24.5
CD at 5 %							2014	2015
To compare weed control measures at same level of planting geometries							2.4	3.0
To compare planting geometry at same or different level of weed control practices							3.5	3.7

4. Conclusion

In the view of the two years experimental findings, it is concluded that a close planting geometry of 30 cm × 20 cm along with pendimethalin 30 E.C PE.@1.0 kg *a.i.*/ha + quizalofop ethyl 5 E.C. PoE @ 50 g *a.i.*/ha at 3-5 leaves stage of weeds followed by mechanical weeding by hand hoe at 30-35 DAT and pendimethalin 30 E.C. PE @1.0 kg *a.i.*/ha followed by mechanical weeding by hand hoe at 30-35 DAT proved effective to increased higher plant height, number of branches, plant spread, leaf area index, plant dry weight/m^2 and per hectare dry herbage yield/ha of *Kalmegh* (*Andrographis paniculata* Nees.) during *Kharif* season of 2014 and 2015.

5. References

1. Bhan MK, Dhar AK, Khan S, Lattoo SK, Gupta KK, Choudhary DK. Screening and optimization of *Andrographis paniculata* (Burm. f.) Nees for total andrographolide content, yield and its components, Scientia Hort. 2006; 107:386-391.
2. FAO, Non-wood forest products 11. Medicinal plants for forest conservation and healthcare. Rome, 1997.
3. Gomez AK, Gomez AA. Statistical Procedure for Agricultural Research. Int. Rice Res. Inst., Los Banos Philippines, 1984.
4. Krishna M, Sunita TP, Kumar A, Dhyani, VC. Effect of date of nursery sowing and planting geometry on growth and dried herb yield of *kalmegh* (*Andrographis paniculata* Nees.). Int. J. Basic and Applied Agric. Res. 2014; 12(1):1-4.
5. Kumar K, Chaudhary HP, Awasthi UD, Sharma DC. Impact of plant density and sowing time on the growth, yield and andrographolide content of *kalmegh (*Andrographis paniculata Nees. Prog. Agric. 2010; 10(1):S6-S9.
6. Okwu DE. Evaluation of the chemical composition of indigenous spices and flavouring Agents. Global J. of Pure and Applied Sci., 2001; 7:455- 459.
7. Ram D, Chandra R, Kumar B. Effect of spacing and organics on growth and herbage yield of *kalmegh* (*Andrographis paniculata* Wall. Ex.Nees). Progressive Hort. 2008; 40(I):69-73.
8. Singh M, Singh A, Tripathi RS, Verma RK, Gupta MM, Mishra HO *et al*. Growth behaviour; biomass and deterpenoid lactones production in *kalmegh* (*Andrographis paniculata* Nees.) strains at different population densities. Agric. J. 2011; 6(3):115-118.
9. Singh M. Effect of irrigation and plant spacing on herb and oil yields of patchouli (*Pagostemon patchouli)*. J. Medicinal and Aromatic Plant Sci. 1996; 18:487-488.
10. Saikia S, Mahanta CL. Effect of steaming, boiling and microwave cooking on the total phenolics, flavonoids and

antioxidant properties of different vegetables of Assam, India. Int. J of Food and Nutritional Sci. 2013; 2(3):47-50.

11. Sanjutha S, Subramanian S, Indu RC, Maheswari J. Integrated nutrient management of *Andrographis paniculata*. Res. J. of Agric. and Biological Sci. 2008; 4(2):141-145.
12. Sharif A, Chauhan SB. Performance of different herbicides in dry-seeded rice in Bangladesh. The Scientific World J Article ID 729418, 2014.
13. Tessmer OL, Jiao Y, Cruz JA, Kramer DM, Chen J. Functional approach to high-throughput plant growth analysis. BMC *Systems Biol*. 7:S17. (Cf: Sarathi *et al.,* 2015. The relationship between leaf area growth and biomass accumulation in *Arabidopsis thaliana*. Plant Sci. 2013. 6:167.
14. Upadhyay RK, Baksh H, Patra DD, Tewari SK, Sharma SK, Katiyar RS. Integrated weed management of medicinal plants in India. Int. J. Medicinal Aromatic Plants. 2011; 1(2):51-56.
15. Zhang X, Hause R.J, Borevitz JO. Natural genetic variation for growth and development revealed by high-throughput phenotyping in *Arabidopsis thaliana.* G3: 29-34. Cf: Sarathi *et al.,* 2015. The relationship between leaf area growth and biomass accumulation in *Arabidopsis thaliana*. Plant Sci. 2012; 6:167.
16. FAO. Non-wood forest products. *Medicinal plants for forest conservation and healthcare*. Rome, 1997, 11.
17. Gomez AK, Gomez AA. Statistical Procedure for Agricultural Research. Int. rice Res. Inst., Los Banos Philippines. 1984.