EFFECT OF NITROGEN AND POTASSIUM NUTRITION ON THE GROWTH AND YIELD OF MULTIPLIER ONION (*Allium cepa* var. *aggregatum*)

THESIS SUBMITTED TO
THE ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, BHUBANESWAR
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

MASTER OF SCIENCE AGRICULTURE
(HORTICULTURE)

BY
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1999

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CERTIFICATE - I

This is to certify that the thesis entitled "**EFFECT OF NITROGEN AND POTASSIUM NUTRITION ON THE GROWTH AND YIELD OF MULTIPLIER ONION (*Allium cepa* var. *aggregatum*)**" submitted for the degree of **MASTER OF SCIENCE IN AGRICULTURE (HORTICULTURE)** to the Orissa University of Agriculture and Technology, Bhubaneswar, is a faithful record of bonafide and research work carried out by **SUNIL KUMAR DASH** under my guidance and supervision. No part of the thesis has been submitted for any other degree or diploma or published in any other form.

The assistance and help received during the course of investigation have been fully acknowledged.

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CERTIFICATE - II

This is to certify that the thesis entitled "**EFFECT OF NITROGEN AND POTASSIUM NUTRITION ON THE GROWTH AND YIELD OF MULTIPLIER ONION (*Allium cepa* var. *aggregatum*)**" submitted by **SUNIL KUMAR DASH** to the Orissa University of Agriculture and Technology, Bhubaneswar, in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURE (HORTICULTURE)**, has been approved by the Students Advisory Committee after an oral examination on the same in collaboration with an External Examiner.

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Sunil Kumar Dash.

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The 30th August, 1999

EFFECT OF NITROGEN AND POTASSIUM NUTRITION ON THE GROWTH AND YIELD OF MULTIPLIER ONION (*Allium cepa* var. *aggregatum*)

ABSTRACT

1. **Title of the thesis** : **Effect of nitrogen and potassium nutrition on the growth and yield of multiplier onion (*Allium cepa* var. *aggregatum*)**

2. **Author** : **SUNIL KUMAR DASH**

3. **Major Advisor** : **Dr. Premananda Mahapatra**
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4. **Degree for which thesis is submitted** : **M.Sc. (Ag) Horticulture**

5. **Year of submission** : 1999-2000

6. **Salient Features:**

An experiment entitled "**Effect of nitrogen and potassium nutrition on the growth and yield of multiplier onion (*Allium cepa* var. *aggregatum*)**" was carried out at Horticulture Research Station, College of Agriculture, Orissa University of Agriculture and Technology (OUAT), Bhubaneswar during the year 1998-99 to study the effect of graded levels of nitrogen and potash on the yield of aggregatum group of onion. The experiment comprised of four levels of nitrogen (i.e. 60, 90, 120 and 150 kg/ha) and three levels of potash (i.e. 40, 60 and 80 kg/ha) which formed 12 treatment combinations. The experiment was laid out in factorial RBD with three replications. Among the different doses of nitrogen and potash tried in the present study, application of 120 kg N/ha along with 80 kg K/ha appears to be the best treatment combination to obtain a good yield of aggregatum onion, where phosphorus @ 80 kg/ha was applied uniformly to all the treatments of the experiment. It was, however, observed that increase in level of nitrogen beyond 120 kg was not resourceful for increasing the production. The result in relation to the storage study revealed that application of nitrogen at lower dose was more helpful in extending the self-life of the aggregatum onion. On other hand, with increase in potash level, there was corresponding increase in self-life of aggregatum onion.

Sunil Kumar Dash.

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ABBREVIATION

g	gram
kg	kilogram
q	quintal
mm	millimetre
cm	centimetre
m	metre
m2	square metre
km	kilometre
/ha	per hectare
@	at the rate of
SE(m)	Standard Error of mean
CD0.05	Critical Difference at 5% level of significance
N	Nitrogen
P	Phosphorus
K	Potash
NS	Not significant
%	percentage
ml	millilitre
Fig.	Figure
oC	degree centigrade
i.e.	that is
C:N	Carbon to Nitrogen ratio
pH	negative logarithm of hydrogen ion concentration

CHAPTER-I

INTRODUCTION

CHAPTER-I

1.0 INTRODUCTION

Vegetables are being considered as an asset providing a vital part of human diet and a good source of income to the growers. Vegetables are considered 'protective supplementary food' as they contain large quantities of minerals. Many of the vegetable crops possess high medicinal value in curing certain diseases and onion is one of the most important vegetable crops recommended for persons suffering from high cholesterol, weakness, lethargy and lack of appetite. Onion is such an important vegetable crop grown commercially in a little over 100 countries in the world. About 3/4th of global production is however, produced from eighteen countries, important of which are China, India, USA, Russia, Japan, Spain, Turkey, Brazil, Egypt, etc. India has the largest area (0.29 million hectares) under onion cultivation in the world, and in production it ranks second, producing 3.35 million tonnes. Presently, India contributes to the tune of 12% of global onion production. This crop has gained the status of a cash crop in Maharashtra and Gujarat because of its high export potential. In India, Maharashtra is the

leading state accounting 20% of the area and 30% of the production of onion. Other important onion producing states of our country are Karnataka, Tamil Nadu, Orissa and Madhya Pradesh. Onion, in our country, accounts for 70% of the total foreign exchange earning from fresh vegetable export. Malaysia, Dubai, Kuwait, Singapore, UAE, Sri Lanka and Bangladesh are the potential export market for onion.

A careful review of the production scenario of onion in India clearly reveals that the productivity of crop in farm land is very low, i.e. 11 tonnes/ha against the world average of 14 tonnes/ha. The yield of onion is mainly influenced by a number of environmental factors along with the cultural practices. The low productivity and storability of onion may also be influenced by non-availability of suitable cultivar for specific agro-ecological conditions and non-adoption of recommended nutritional management.

Among all the cultural practices that contribute to the success of onion crop, fertilizer management appears to be the most important. Onion is a gross feeder of plant nutrients. A lot of work has been done to find out the nutritional requirement of onion, particularly the bulb onion. But work in relation to fertilizer requirement of 'aggregatum' group of onion is very scanty. Therefore, an attempt has been made in this experiment to study the effect of graded levels of nitrogen and potash to increase the productivity and storability of aggregatum onion. The principal objectives of this study are :

- to study the response of aggregatum onion to the graded levels of N and K.
- to study the effect of N and K nutrition on storage life of aggregatum onion.

CHAPTER-II

REVIEW OF LITERATURE

CHAPTER-II

2.0 REVIEW OF LITERATURE

In the present chapter, an attempt has been made to review the available literature, in relation to the effect of nitrogen and potash on the performance of aggregatum onion as well as bulb onion. Because of the paucity of literature on this type of aggregatum onion, references on bulb onion have also been collected and reviewed in the present chapter.

2.1 Effect of Nitrogen

Ewing and Pearsall (1929) found that an abundant supply of nitrogen increases the water content of tissue. He also considered that increased succulence results from a lower respiration of plants with an abundant supply of nitrogen as compared to those which in some manner lower the hydrogen ion concentration and thus, allow a greater swelling of protoplasmic colloids that would retard the loss of water by respiration.

Miller (1938) reported that application of nitrogen in general increases the sulphur content of onion and sulphur functions as the building materials for the formation of protein and other constituent of the plant, therefore the dry matter content of different plant parts, viz. leaf pseudostem, increased with rise in nitrogen level.

Steward (1947) reported that the application of nitrogen in different doses have marked effect on height of the plant.

Kato (1965) reported that top dressing of nitrogen enhanced photosynthesis in onion leaves and promoted bulb thickness in onion.

Singh and Batra (1972) reported that increase in doses of nitrogen level from 50 to 150 kg/ha increases the bulb size.

Bottcher et al. (1977) reported better quality of onion, when nitrogen @ 80 kg/ha was applied at the time of basal dressing and supplemented with 50 kg/ha at the time of top-dressing.

Hassan (1977) marked highest yield when nitrogen @ 95 kg/ha was applied in split doses, but average yield was marked when nitrogen @ 120 kg/ha was applied at a time.

Wilson (1977) observed that the yield enhancement was slight at higher level of nitrogen.

Agrawal et al. (1981) observed higher satisfactory yield only with nitrogen @ 80 kg/ha and the highest yield was obtained when N P K was applied @ 80, 40

and 80 kg per hectare. It has been further reported that nitrogen has got a satisfactory effect on yield.

Villagram and Escaff (1982) studied that the marketable yield of onion was increased linearly, with increase of nitrogen, but the average weight of individual marketable bulb decreased with increased nitrogen application.

Hassan (1984) observed best bulb yield with nitrogen @ 90 kg/ha when applied but at increasing level the bulb doubling was increased.

Muzika (1986) stated that rising the 'N' rate from 120 to 180 kg/ha increased the yield only slightly and reduces the storability of onion.

Henriksen et al. (1987) observed that when nitrogen was applied @ 120 kg/ha, it increased the bulb yield and also matured the crop 9 days earlier than control.

Srinivas and Nayak (1987) marked 165.1 q/ha yield of onion with 'O' level of nitrogen, but it has been increased to 563 q/ha at highest rate of nitrogen (i.e. 200 kg/ha).

Minotti and Store (1988) observed that nitrogen always stimulated the early development and also accelerated the maturity.

Palled et al. (1988) marked 12.2 to 26.4% higher yield with 100 kg of 'N'/ha, that applying 75 and 50 kg of nitrogen per hectare.

Singh and Dhankar (1989) observed that high level of nitrogen would reduce the neck thickness.

Vishnushukla et al. (1989) reported that highest bulb yield and bulb weight obtained with 120 to 160 kg N per hectare. However, no significant difference between 'N' treatment (0, 40, 80, 120 and 160 kg/ha) for keeping quality.

Pandey et al. (1990) also observed that 100 kg/ha nitrogen gives good size of bulbs for marketable purposes.

Pandey and Ekpo (1991) reported that maximum number of leaves per plant with nitrogen 160 kg/ha, when applied in 2 equal split doses and at 10 and 25 days after planting. But the highest bulb yield with average bulb weight was obtained with nitrogen @ 120 kg/ha.

Singh and Sharma (1991) studied that with each increase in the levels of nitrogen up to 80 kg per hectare, there was increment in bulb diameter and yield. But increasing nitrogen from 80 kg to 120 kg per hectare, there was no significant increase in the yield and bulb diameter.

Singh and Rajput (1992) studied that through a RBD experiment, 3 levels of urea 0, 100 and 200 kg/ha gave 8.51, 11.49 and 15.24 number of leaves; 2.35, 3.97 and 5.52 cm diameter of the bulb; 12.61, 93.30 and 83.54 g weight of bulb and 100.96, 176.13 and 218 q/ha of yield respectively each.

Betal et al. (1994) observed that with medium and high level of nitrogen (168 to 224 kg/ha) application there was increment in yield. But at lower to medium level of nitrogen (84 to 168 kg/ha), the bulb size and weight increased.

Sharma et al. (1994) marked the highest yield of onion with nitrogen at 150 kg/ha which is applied in two splits.

Vissar et al. (1995) found a fixed rate of nitrogen (100-125 kg/ha) yielded better result.

Mehla et al. (1996) observed the increment of bulb weight, size and yield with increment of nitrogen up to 120 kg/ha. But further increase in nitrogen, there was decrease in yield, bulb weight and size of the onion.

Vachani and Patel (1996) observed highest plant height, more number of leaves per plant, maximum bulb weight, bulb diameter and also good yield with 150 kg of 'N'/ha.

Kumar et al. (1998) reported that survival of seedlings, height of the plant, length of longest leaf, diameter of bulb, number of leaves per plant, fresh and dry root of plant and yield of bulbs (q/ha) are maximum where nitrogen was applied @ 150 kg ha in comparison to 75 kg nitrogen per hectare and control.

2.2 Effect of Potash

Hawthorn (1936) observed that higher dose of N reduces the storage life of onion and increasing dose of K helps in getting healthy bulbs with stronger skin.

Das and Dhyani (1956) and Singh and Jain (1959) reported that application of nitrogen and potassium each @ 80 lbs/acre brought about a phenomenon in plant growth. He also observed favourable effect of potassium on growth of onion.

Downs and Carolus (1961) reported that up to certain limit of dose of nitrogen, there was increase in number of leaves in onion, it was found that 80 lbs of nitrogen and potassium give maximum number of leaves.

Zink (1962) reported that an average crop of onion removed on an average of 65.6 lbs of N and 9.48 lbs of K.

Das and Sahoo (1967) reported that potassium fertilizer had the effect on neck thickness of garlic as it was increased with the increased level of potassium and significant increase was recorded when 112 kg/ha was applied.

Singh and Kumar (1969) reported that P and K at higher rates improved the keeping quality of bulbs and moderated adverse effect of N.

Sundarsan (1979) reported that bulbs grown when potash was applied in lower amount, showed highest sprouting where K application with higher amount reduced it.

Desmukh et al. (1984) reported highest yield (534 q/ha) with P_2O_5 at 80 kg/ha with K_2O at 37.5 kg/ha.

Satyanarayan and Arora (1984) reported that there is increase in bulb yield by 60 kg N per hectare but there is no significant effect by application of 46 kg of K_2O per hectare.

Singh and Dhankar (1989) reported that bulb weight loss and incidence of rotting and sprouting were increased by increasing N application (80 to 160 kg/ha)

and reduced by application of K_2O (100 kg/ha). Bulb grown with 80 kg N per hectare and 100 kg K_2O per hectare had the best storage quality.

Boloch et al. (1991) observed that the highest bulb yield of onion was obtained with 125 kg N and 75 kg K_2O per hectare.

Singh and Dhankar (1991) reported that rotting of bulbs increased with increase in 'N' doses being highest under 160 kg/ha and lowest under 80 kg/ha. However, it decreases from 60 kg to 100 kg K_2O per hectare.

Sharma (1992) reported that bulb yield and green leaves were higher from seeds that seedlings when @ 40 kg K_2O per hectare was applied.

Sher (1996) suggested that a part of phosphorus and potash should be applied at post emergence stage along with nitrogen dressing and that will give best result on yield of onion.

2.3 Effect of Nitrogen, Phosphorus and Potash

Yawalkar et al. (1962) reported that the onion crop yielding 275 q/ha removes 81 kg N, 41 kg P_2O_5 and 75 kg K_2O.

Malachowski (1974) studied the effect of N, P and K in different aspect of onion yield, size of the bulb and weight of bulb. It was further observed that nitrogen at optimum level yielded maximum but the yield was depressed with higher level of nitrogen. With regards to P and K, excess P did not have any adverse effect, where as excess K had an adverse effect.

Petkov et al. (1976) observed highest yield of large sized onion bulb with good storability applying 180, 270 and 60 kg per hectare of N, P and K, respectively.

Rahman et al. (1976) reported that nitrogen at higher rate decreases the yield and bulb diameter as well, whereas potassium at higher rate increases both the yield and bulb diameter. But phosphorus at higher rate increases the yield and decreases the bulb diameter.

Flones (1977) found during his four years trial that raising the levels of nitrogen consistently increased the yield and the similar effect has been marked with each increasing levels of phosphorus. But in case of potassium, it had not any significant effect on yield. It was further reported that raising of nitrogen levels was not good for their storage quality.

Painter (1977) studied that higher levels of nitrogen application did not have any beneficial effect on yield and storage quality of onion bulbs.

Hassan and Ayoub (1978) reported that with each increase in the levels of nitrogen, there was significant increase in the total yield and average bulb size. Likewise, the similar effect has been marked with each increasing level of phosphorus. But in case of potassium, its effect on yield and bulb size was negligible.

Singh (1978) marked that nitrogen and phosphatic fertilizer had got a significant response on yield of onion. The highest yield was obtained by applying 112.5 kg and 196.9 kg per hectare of N and P, respectively.

Madan and Sandhu (1983) obtained highest yield in onion by applying 185, 113 and 105 kg per hectare of N, P and K, respectively. But it has been further reported that 176, 98, 96 kg per hectare of N, P and K, respectively, was the most economic dose for onion as regard the yield is concerned.

Patil et al. (1983) studied that, with increment of the levels of nitrogen and phosphorus, there was increment of yield in onion, but potassium had little effect on yield of onion.

Achar et al. (1984) obtained highest yield with NPK @ 80, 25 and 80 kg per hectare. It has been again marked that the yield was reduced correspondingly with the reduction of fertilizer.

Lima et al. (1984) obtained best return with phosphorus @ 130 kg/ha without any nitrogenous fertilizer in the soils, having high phosphate and organic matter. But in low phosphatic and organic matter soil, best return was obtained by applying P_2O_5 @ 80 kg/ha along with 'N' @ 145.1 kg/ha.

Mitrach and Burileanu (1984) marked highest yield of onion with NPK at 150, 150 and 200 kg per hectare respectively.

Path et al. (1984) observed largest bulb diameter with 'N' at 150 kg/ha and phosphorus at 150 kg/ha. But potassium had no appreciable effect.

Anzer and Tavira (1986) reported best yield (121.7 t/ha) with N, P and K @ 120 kg/ha each, when applied at seedling stage.

Britvich and Goncharenka (1986) obtained best yield with N, P and K @ 90, 135 and 90 kg per hectare, respectively.

Duque et al. (1989) observed that the onion plant demanded for nitrogen and potash was high during early stage of growth, whereas phosphorus requirement was continuous throughout the development.

Jayabharathi (1989) conducted an experiment with three levels of nitrogen, phosphorus and potassium @ 0, 50, 75 kg each/ha on onion C.V. CO_4 (aggregatum). The experiment was laid out in a factorial randomised block design with two replications. From this experiment, it was observed that with each increase in the level of nitrogen, phosphorus and potassium from 50 kg to 75 kg per hectare, there was correspondingly significant increase in the yield of aggregatum onion. Further, it was concluded that 75 kg of N, P and K each per hectare was the best for aggregatum onion.

Galbiatti and Castellane (1990) reported that N, P and K dose of 130:240:115 kg/ha and irrigation at 125% of daily evaporation (average of 5 mm) produced maximum plant growth.

Katwale and Saraf (1994) reported that N, P and K @ 125, 60 and 100 kg per hectare gave largest bulb yield and gave highest return.

Singh (1995) studied nitrogen application above 50 kg/ha and phosphorus application above 30 kg/ha was not beneficial.

Subbiah et al. (1996) conducted an experiment with four levels of nitrogen (0, 30, 60 and 90 kg/ha), two levels of phosphorus (0 to 60 kg/ha) and two levels of potassium (0 and 30 kg ha). The treatments were replicated thrice in a randomised block design at Tamil Nadu Agriculture University Farm. From that experiment, it was reported that by the application of 60:60:30 kg of N, P_2O_5 and K_2O per hectare, the highest bulb yield (41.10 ha) was obtained and with further increase in the level of nitrogen, there was corresponding decrease in the yield.

CHAPTER-III

MATERIALS AND METHODS

CHAPTER-III

3.0 MATERIALS AND METHODS

The techniques followed for the investigation and the materials employed which ultimately determine the proficiency as well as efficiency and finally the success of the experiment have been enumerated in detail in this Chapter. The factors included and the methods adopted in the present investigation, therefore, need some explanation which is as follows.

3.1 Experimental site

The experiment entitled "**Effect of nitrogen and potassium nutrition on the growth and yield of multiplier onion (*Allium cepa* var. *aggregatum*)**" was carried out at the Horticultural Research Station, OUAT, Bhubaneswar in the year 1998-99.

3.2 Cropping history of experimental field

The experimental plot in the year 1995-96 and 1997-98 was left fallow and during 1996-97 onion was cultivated in rabi season. But in the year 1998-99, aggregatum onion (present study) was cultivated in the rabi season only.

Year	Kharif	Rabi	Summer
1995-96	Fallow	Onion	Fallow
1996-97	Fallow	Onion	Fallow
1997-98	Fallow	Fallow	Fallow
1998-99	Fallow	Onion (aggregatum)	Fallow

3.3 Soil

A composite soil sample was collected to determine the basic status of the soil and analysed before the commencement of the present experiment. The physico-chemical composition of the soil of the experimental field is given below:

Table-1 : Physico-chemical composition of soil of the experimental plot. (Soil depth 15 cm)

Mechanical composition :

	Constituents	Percentage (Air dry basis)	Method followed
1.	Sand		
	(a) Coarse sand	50.94	
	(b) Fine sand	28.78	
2.	Silt	8.65	Bouyoucos Hydrometer (Bouyoucos, 1962)
3.	Clay	11.70	-do-
4.	Textural class	Sandy loam	

Chemical composition :

	Constituents	Amount present (Oven dry basis)	Method followed
1.	Available nitrogen	0.039%	Kjeldahl's method (Jackson, 1973)
2.	Available phosphorus	0.7 kg/ha	Bray's strong reagent (Bray, 1948)
3.	Available potassium	125.0 kg/ha	Morgan's reagent (Jackson, 1962)
4.	Organic carbon	0.45%	Walkley and Black rapid titration method (Page et al., 1982)
5.	Soil pH	5.5	Blackman's pH meter (Piper, 1966)
6.	C:N ratio	11.54 : 1	-

The soil of the experimental field was thus, found to be sandy loam in texture, having low on total nitrogen content and available phosphorus, but some what rich in potash. The soil pH was slightly in acidic side.

3.4 Climate

Bhubaneswar comes under tropical climatic zone. It is located on 22°15′ North latitude and 80°22′ East longitude and on an altitude of 25.5 metre above the mean sea level. It is around 62 km away from the Bay of Bengal towards west. The average maximum temperature during this period varies between 28.4 to 37.3°C and the average minimum temperature during the coldest month of January varies between 13.5 to 28.4°C. The meteorological data obtained for the period of the experimentation, i.e. from November, 1998 to March, 1999 and presented below.

Table-2 : Meteorological data from November, 1998 to March, 1999.

Month	Temperature (°C)			Relative Humidity (%)			Sun shine (hr)	Evaporation (mm)
	Max	Min	Mean	Max	Min	Mean		
Nov'98	30.6	20.7	25.6	92	60	76	7.2	3.6
Dec'98	28.6	13.3	20.9	92	41	66	8.6	3.4
Jan'99	28.4	13.5	21.0	90	39	64	8.3	3.1
Feb'99	33.5	18.1	25.8	94	39	67	8.3	4.1
Mar'99	37.3	22.0	29.6	94	38	66	8.2	6.0

3.5 Preparation of the field

The general preplanting operations carried out in the field were as follows :

Date	Operations	Remark
16.11.98	Ploughing	By tractor
18.11.98	Ploughing and cross ploughing	By tractor
20.11.98	Weeding	By manual labour
23.11.98	Weeding and layout of field	By manual labour
24.11.98	Layout by making plot size (1.5m x 1.5m) and each plot is manured with 1 basket of FYM + Aldrin 5% D @ 25 g/plot	By manual labour
25.11.98	Planting of bulblets in plots	By manual labour

3.6 Experimental technique

The following methods have been adopted for the experiment.

3.6.1 Design of experiment and plan of layout

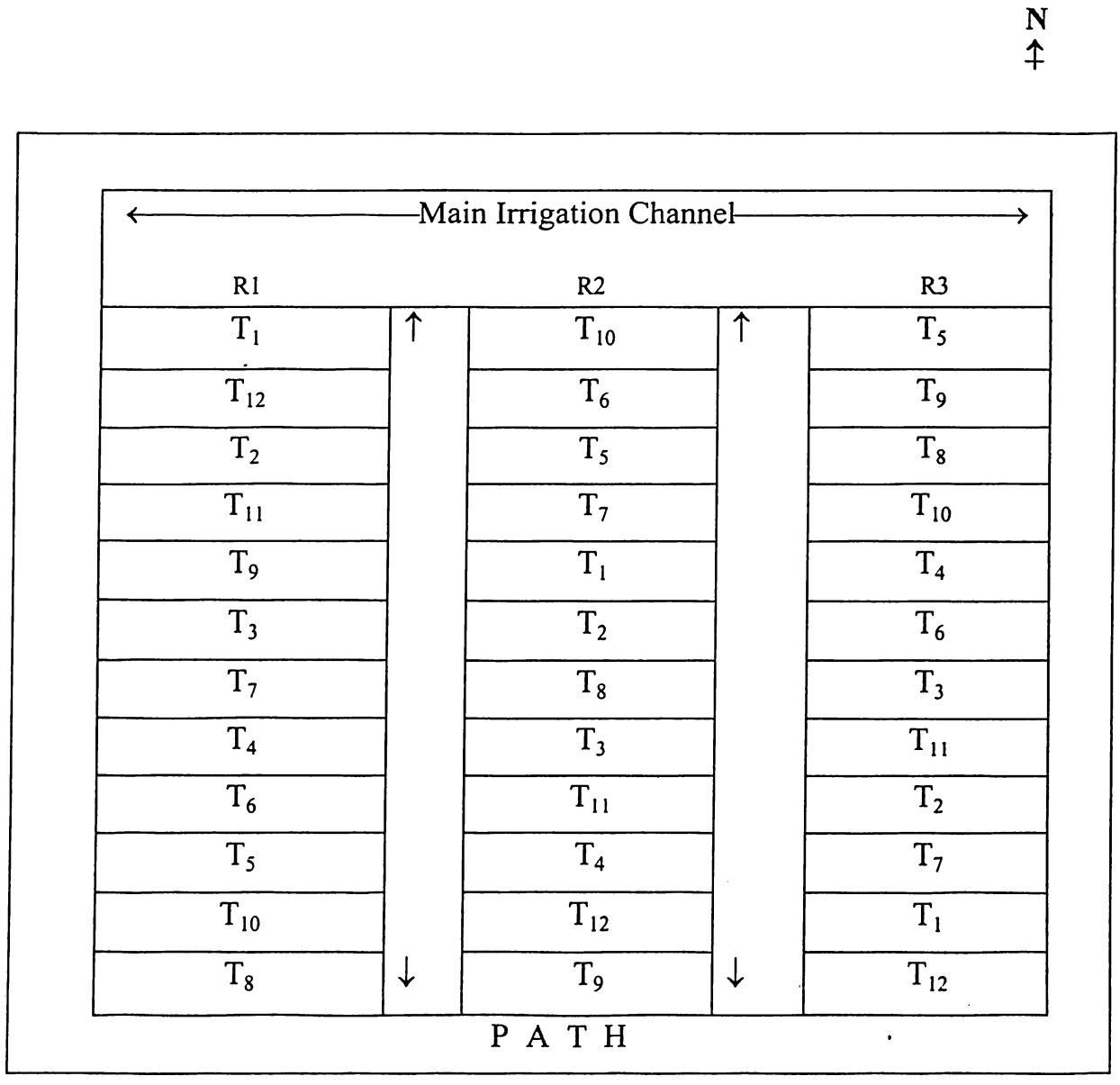
The experiment constituted of 12 treatments comprising four levels of nitrogen (60, 90, 120, 150 kg/ha) in the form of urea and three levels of potash (40, 60, 80 kg/ha) in the form of muriate of potash (MOP) keeping phosphorus constant (80 kg/ha) in the form of single super phosphate (SSP) for all the treatments.

The planting of bulblets were done in three blocks taking each block in a single replication. The experiment was laid out in randomised block design (factorial).

3.6.2 Factors, Levels/Treatments and Notations :

Factors	Levels/Treatments	Notations
1. Nitrogen	(a) 60 kg/ha	N_1
	(b) 90 kg/ha	N_2
	(c) 120 kg/ha	N_3
	(d) 150 kg/ha	N_4
2. Potash	(a) 40 kg/ha	K_1
	(b) 60 kg/ha	K_2
	(c) 80 kg/ha	K_3

3.6.3 Site map and plan layout of the experimental plot



Bund = 0.3 m

Irrigation channel = 0.9 m

Main irrigation channel = 1.0 m

Total experimental plot size = (22.9 x 6.9) m^2

The details of layout are given below :

1.	Design of layout	Randomised Block Design(Factorial)
2.	Number of treatments	12 (T_1, T_2, T_3, ..., T_{12})
3.	Number of replications	3 (R_1, R_2, R_3)
4.	Total number of plots	36
5.	Plot size	1.5 x 1.5 m
6.	Spacing	
	(a) Row to row	15 cm
	(b) Plant to plant	10 cm
7.	Number of rows per plot	10
8.	Number of plants per row	15
9.	Number of plants per plot	150
10.	Width of the irrigation channel	90 cm
11.	Width of the bund separating blocks	30 cm
12.	Length of the experimental field	29.9 m
13.	Width of the experimental field	6.9 m
14.	Net Cropping area	81.0 m^2
15.	Area of the experimental field	158.01 m^2

3.6.4 Source of planting material

The aggregatum onion bulblets were collected from Khurda market which is about 20 km away from Horticultural Research Station of the OUAT, Bhubaneswar.

3.6.5 Treatment combinations, notations and nutrients required

Treatment combinations and their notations are given in Table-3(a) and the amount of nutrients required in Table-3(b).

Table-3 (a) : Treatment combinations and their notations.

Treatments	Combinations of dose	Final notation
N_1+K_1	60 kg of N + 40 kg of K	T_1
N_1+K_2	60 kg of N + 60 kg of K	T_2
N_1+K_3	60 kg of N + 80 kg of K	T_3
N_2+K_1	90 kg of N + 40 kg of K	T_4
N_2+K_2	90 kg of N + 60 kg of K	T_5
N_2+K_3	90 kg of N + 80 kg of K	T_6
N_3+K_1	120 kg of N + 40 kg of K	T_7
N_3+K_2	120 kg of N + 60 kg of K	T_8
N_3+K_3	120 kg of N + 80 kg of K	T_9
N_4+K_1	150 kg of N + 40 kg of K	T_{10}
N_4+K_2	150 kg of N + 60 kg of K	T_{11}
N_4+K_3	150 kg of N + 80 kg of K	T_{12}

Table-3 (b) : Amount of different nutrients required.

	Urea in g	MOP in g
T_1 (N_1+K_1 i.e. 60 kg of N + 40 kg of K/ha)	29.34	15.0
T_2 (N_1+K_2 i.e. 60 kg of N + 60 kg of K/ha)	29.34	22.5
T_3 (N_1+K_3 i.e. 60 kg of N + 80 kg of K/ha)	29.34	30.0
T_4 (N_2+K_1 i.e. 90 kg of N + 40 kg of K/ha)	44.02	15.0
T_5 (N_2+K_2 i.e. 90 kg of N + 60 kg of K/ha)	44.02	22.5
T_6 (N_2+K_3 i.e. 90 kg of N + 80 kg of K/ha)	44.02	30.0
T_7 (N_3+K_1 i.e. 120 kg of N + 40 kg of K/ha)	58.70	15.0
T_8 (N_3+K_2 i.e. 120 kg of N + 60 kg of K/ha)	58.70	22.5
T_9 (N_3+K_3 i.e. 120 kg of N + 80 kg of K/ha)	58.70	30.0
T_{10} (N_4+K_1 i.e. 150 kg of N + 40 kg of K/ha)	73.37	15.0
T_{11} (N_4+K_2 i.e. 150 kg of N + 60 kg of K/ha)	73.37	22.5
T_{12} (N_4+K_3 i.e. 150 kg of N + 80 kg of K/ha)	73.37	30.0

Note : Single super phosphate (S.S.P.) is constant for all the treatments @ 80 kg of P/ha) i.e. 112.5 gm per plot (1.5 m x 1.5 m).

3.6.6 Planting of bulbs

Sprouted bulblets, pretreated with 0.3% mancozeb solution were planted in the well prepared plots. One hundred fifty bulblets were planted in each plot. The planting was conducted with a spacing (15 x 10) cm and was completed on 25.11.1998. After planting, bulblets were covered with a thin layer of soil and finally covered with dry grass mulch and subsequently, hand watering was given with the help of rose cane. Subsequent watering was continued with the help of rose cane till the sprouting of bulblets.

3.6.7 Application of manure and fertilizer

Well decomposed FYM @ 1 basket per plot was added at the time of final plot preparation. The fertilizer mixture containing N, P, K, i.e. @ half nitrogen, full phosphorus (all treatments) and full amount of potash (as per treatment) were applied as basal dressing before the planting of bulblets in each treatment. Rest half of nitrogen (as per treatment) were applied at 45 days after planting.

3.6.8 Irrigation

Hand watering was given on each alternate days at the initial stage for the sprouting of bulblets. Afterwards flow irrigation was provided at an interval of 8-10 days during the entire crop season.

3.6.9 Intercultural operations

Hoeing, weeding and earthing up were done four times during the entire period of the experimentation. Besides, one more extra earthing was carried out to ensure the swelling of bulblets remain inside the soil.

3.6.10 Plant protection

To protect the crop from the attack of termites and other insect pests, BHC 5% dust, Ekalux (2 ml/litre) were applied at different times during the experimentation followed by irrigation.

3.6.11 Harvesting

The bulbs were matures in the beginning of March as the plants show weathering condition. Few bulbs as a sample from among the border plants were harvested to see the maturity. Subsequently, a very light irrigation was provided and final harvesting was done on 08.03.1999.

3.7 Technique of study

The following techniques have been adopted in this study.

3.7.1 Method of sampling

The periodical observations of different growth parameters of the plant as influenced by the treatments were recorded by selecting ten number of plants at random in each plot leaving the border plants.

3.7.2 Method of characters studied

Observations on the following characters were recorded on the selected sample plants in each treatment.

(a) **Height of the plant :** Height of plant is measured from base of the bulblet up to tip of highest leaflet and expressed in centimetres.

(b) **Number of leaves per plant :** All the functioning leaves retained by the sample plant were counted and recorded by numbers.

(c) **Fresh weight of roots :** After harvesting the sample plants, the bulbs along with roots were washed thoroughly and the roots were collected by separating from the bulbs. The fresh weight of collected roots of ten sample plants were taken and expressed in grams.

(d) **Number of bulblets per clump :** Clumps of ten sample plants were harvested randomly from each treatment and number of bulblets per clump were counted.

(e) **Diameter of bulblets :** Ten numbers of bulblets were collected randomly from sample plants which were measured for the maximum diameter of bulblets with the help of thickness gaugemeter and were expressed in centimetres.

(f) **Weight of bulblets :** From each treatments, bulblets were collected and mixed together. Random sample of ten number of bulblets were collected, weighed and expressed in grams.

(g) **Weight of the clumps :** The sample plants after harvesting were considered for taking the clump weight. The terminal dried, green leaves as well as roots were removed and the individual clump weight of ten sample plants were taken and expressed in grams.

(h) **Yield per hectare :** The yield of bulb per hectare were calculated by taking the yield per plot into consideration and was expressed in terms of quintals per hectare.

(i) **T.S.S. :** The sample bulbs were cut into pieces and grinded with the help of mortar and pestle. Then the juice was extracted and tested with the help of refractometer and expressed in degree Brix.

(j) **Storage study :** The sample bulblets (100 each per treatment) were taken and stored in the laboratory condition to study the self life. Observations were recorded on 30, 60, 90, 120 and 150 days of storage. The discoloured, rotted, shrivelled onion bulblets were discarded and the healthy, good bulblets were taken for consideration and counted and expressed in numbers and analysed statistically.

3.8 Statistical analysis

Data collected on various parameters were statistically analysed in Random Block Design (Factorial). The 5% level of F-test have been used for testing of significance of the findings. Appropriate standard error for each factor was worked out and to compare the two treatment means the critical difference (CD) was also calculated at 5% level of significance using the formula (Panse and Sukhatme, 1985) :

$$SE(m) \text{ for treatments} = (EMS/r)^{1/2}$$

where, EMS = Error mean of squares

r = Number of replicates

CD (5%) for treatment = SE(m) x 1.414 x t value at error degrees of freedom

CHAPTER-IV

EXPERIMENTAL FINDINGS

CHAPTER-IV

4.0 EXPERIMENTAL FINDINGS

Observations on various plant characters were recorded during the course of the study entitled "**Effect of nitrogen and potassium nutrition on the growth and yield of multiplier onion (*Allium cepa* var. *aggregatum*)**".

The detailed findings of the experiments are presented in this chapter. The tabulated data were statistically analysed with a view to find out the significant effect of different characters which are presented in the Appendices. The data are presented in tabular forms and relevant standard error of mean and critical difference (CD) at 5% level of significance are also presented. The data are also presented graphically wherever necessary.

4.1 Height of the plant

The height of the plant has been significantly influenced by the levels of nitrogen and potash and also their interactions indicated below.

Table-4 : Height of the plant (cm) as influenced by the different levels of nitrogen and potash.

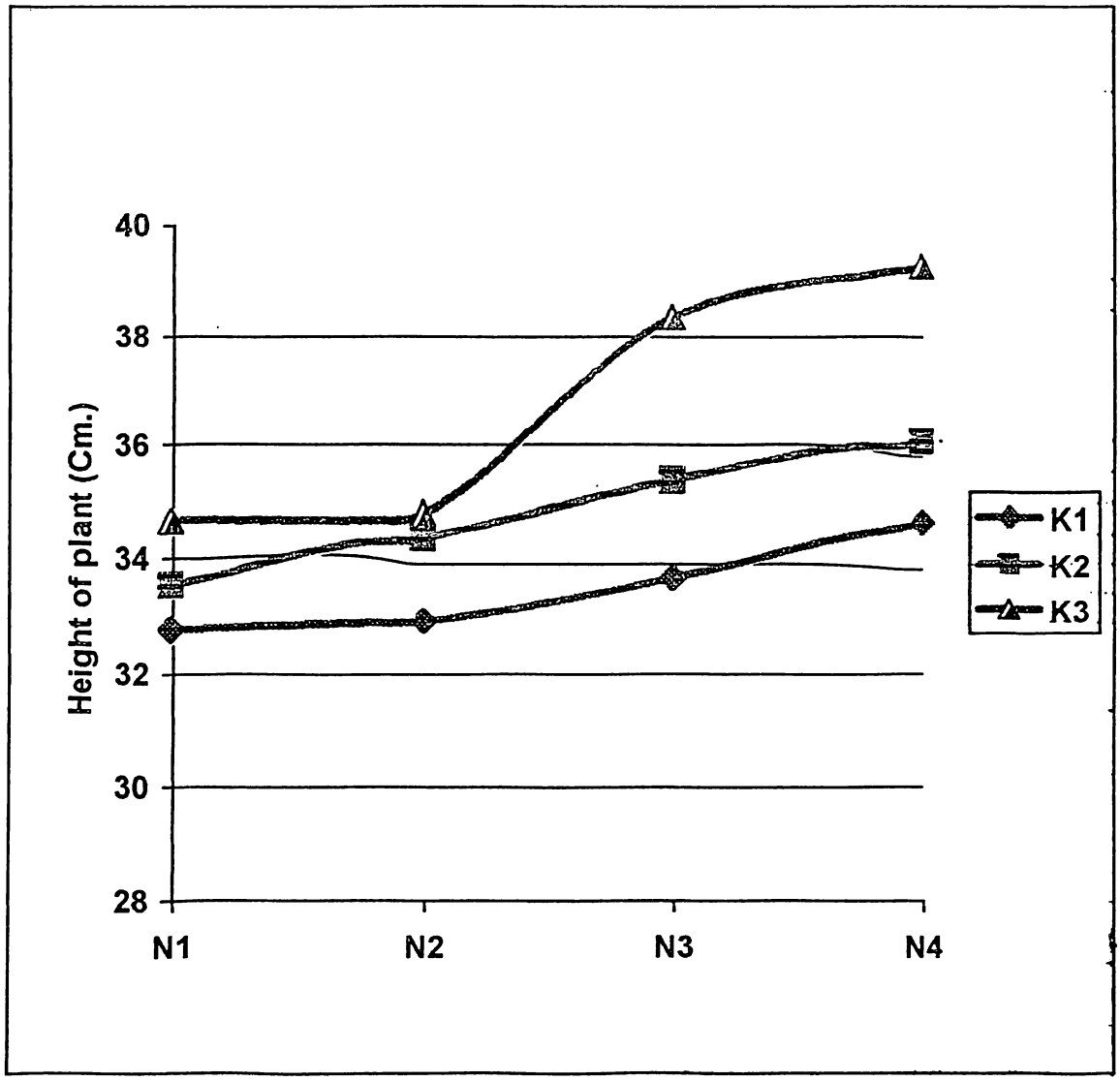
	K_1	K_2	K_3	Mean (N)
N_1	32.75	33.52	34.61	33.62
N_2	32.95	34.43	34.85	34.07
N_3	33.73	35.39	38.33	35.81
N_4	34.85	36.23	39.25	36.77
Mean (K)	33.57	34.89	36.76	

	N	K	N x K
$SE(m)_{\pm}$	0.133	0.115	0.229
$CD_{0.05}$	0.275	0.238	0.476

With each increase in levels of nitrogen from 60 kg to 150 kg per hectare, correspondingly significant increase in the height of the plant was recorded. However, maximum height of plant was recorded with N_4 (36.77 cm). Likewise, with each increase in the levels of potash from 40 kg to 80 kg per hectare, there was correspondingly significant increase in the height of the plant and, thus, the maximum height of the plant was recorded under K_3 (36.76 cm).

As regards the effect of interaction, the maximum plant height was recorded under the treatment combination N_4K_3 (39.25 cm), which was found to be significantly superior than rest of the treatment combinations.

Fig.1 : Height of the plant as influenced by different levels of N and K



4.2 Number of leaves per plant

The number of leaves per plant (at 50 DAT) has also been significantly influenced by the graded levels of nitrogen, potash and their interactions indicated below.

Table-5 : Number of leaves per plant as influenced by the different levels of nitrogen and potash.

	K_1	K_2	K_3	Mean (N)
N_1	15.9	16.8	18.3	17.0
N_2	17.6	18.5	20.5	18.86
N_3	18.9	19.5	20.8	19.74
N_4	19.1	20.8	20.9	20.24
Mean (K)	17.87	18.90	20.12	

	N	K	N x K
$SE(m)_{\pm}$	0.165	0.143	0.286
$CD_{0.05}$	0.343	0.297	0.594

With each increase in the levels of nitrogen, their was corresponding increase in number of leaves per plant up to N_4 level. However, the maximum number of leaves per plant was recorded with N_4 (20.26) and minimum at N_1 (17.0).

Likewise, with each increase in the levels of potash from 40 kg to 80 kg per hectare, there was a corresponding increase in the number of leaves per plant. However, maximum number of leaves per plant was recorded at K_3 (20.12) and minimum at K_1 (17.87).

As regards the effect of interaction, the maximum number of leaves was recorded at N_4K_3, which also remained at par with all the treatment combinations of N_2K_3, N_3K_3 and N_4K_2.

4.3 Fresh weight of roots

Appendix-III clearly indicated that the fresh weight of roots was significantly influenced by different levels of nitrogen, potash and their interactions.

Table-6 : Fresh weight of roots (g) as influenced by the different levels of nitrogen and potash.

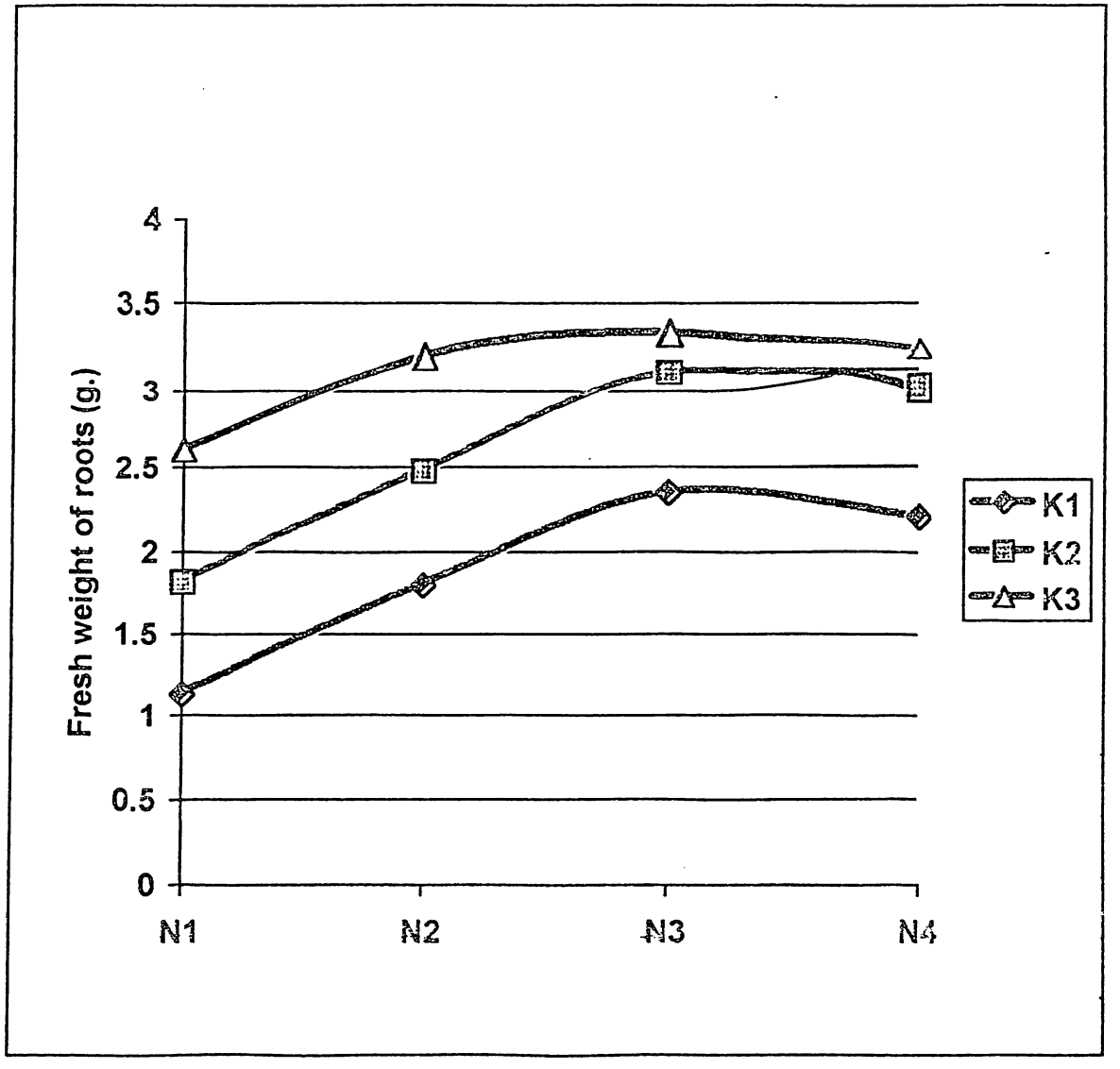
	K_1	K_2	K_3	Mean (N)
N_1	1.13	1.82	2.61	1.85
N_2	1.80	2.48	3.21	2.49
N_3	2.35	3.12	3.34	2.93
N_4	2.21	2.90	3.15	2.75
Mean (K)	1.87	2.58	3.07	

	N	K	N x K
$SE(m)_{\pm}$	0.085	0.074	0.149
$CD_{0.05}$	0.177	0.154	0.308

From Table-6, it was revealed that with each increase in the levels of nitrogen, i.e. from 60 kg to 120 kg per hectare, there was correspondingly significant increase in the fresh weight of roots. But with further increase of nitrogen up to 150 kg per hectare, there was significant decrease in the fresh weight of the roots. However, the maximum fresh weight of the roots was recorded in N_3 (2.93 g) and lowest weight was recorded at N_1 (1.85 g).

With each increase in potash level from 40 kg to 80 kg per hectare, there was corresponding increase of fresh weight of roots was observed. The maximum fresh weight of roots was recorded at K_3 (3.07 g) and minimum at K_1 (1.87 g).

Fig.2 : Fresh weight of roots as influenced by different levels of N and K



As regards, the effect of interaction, the maximum fresh weight of roots was marked at N_3K_3 (3.34 g), which was found to be significantly superior than all the treatment combinations except N_2K_3, N_3K_2 and N_4K_3. However, these are statistically at par with N_3K_3.

4.4 Number of bulblets per clump

With references to Appendix-IV, the number of bulblets per clump was also significantly influenced by the graded levels of nitrogen, potash and their interactions.

Table-7 : Number of bulblets per clump as influenced by the different levels of nitrogen and potash.

	K_1	K_2	K_3	Mean (N)
N_1	4.4	4.5	4.7	4.53
N_2	6.6	6.8	7.0	6.80
N_3	7.4	7.7	8.1	7.73
N_4	7.5	7.6	7.8	7.63
Mean (K)	6.47	6.65	6.90	

	N	K	N x K
$SE(m)_{\pm}$	0.149	0.129	0.259
$CD_{0.05}$	0.311	0.269	0.538

From Table-7, it is revealed that with each increase in the levels of nitrogen from 60 kg to 120 kg per hectare, there was corresponding increase in the number of bulblets per clump. But, with further increase in the levels of nitrogen beyond 120 kg per hectare, there was corresponding decrease in the number of bulblets per clump and, thus, the highest number of bulblets per clump was recorded under N_3 (7.73) which is at par with N_2.

Likewise, with each increase in the levels of potassium from 40 kg to 80 kg per hectare, there was corresponding increase in the number of bulblets per clump. However, the highest number of bulblets per clump was recorded at K_3 (6.9), which also remained at par with K_2 and K_1.

As regards the interaction effect between nitrogen and potash, the highest number of bulblets per clump was recorded at N_3K_3 (8.1), which remained at par with other treatment combinations like N_3K_2, N_4K_1, N_4K_2 and N_4K_3.

4.5 Diameter of bulblet (cm)

Referring to Appendix-V, it was concluded that the diameter of bulblet has been influenced significantly with the graded levels of nitrogen, potash and their interactions.

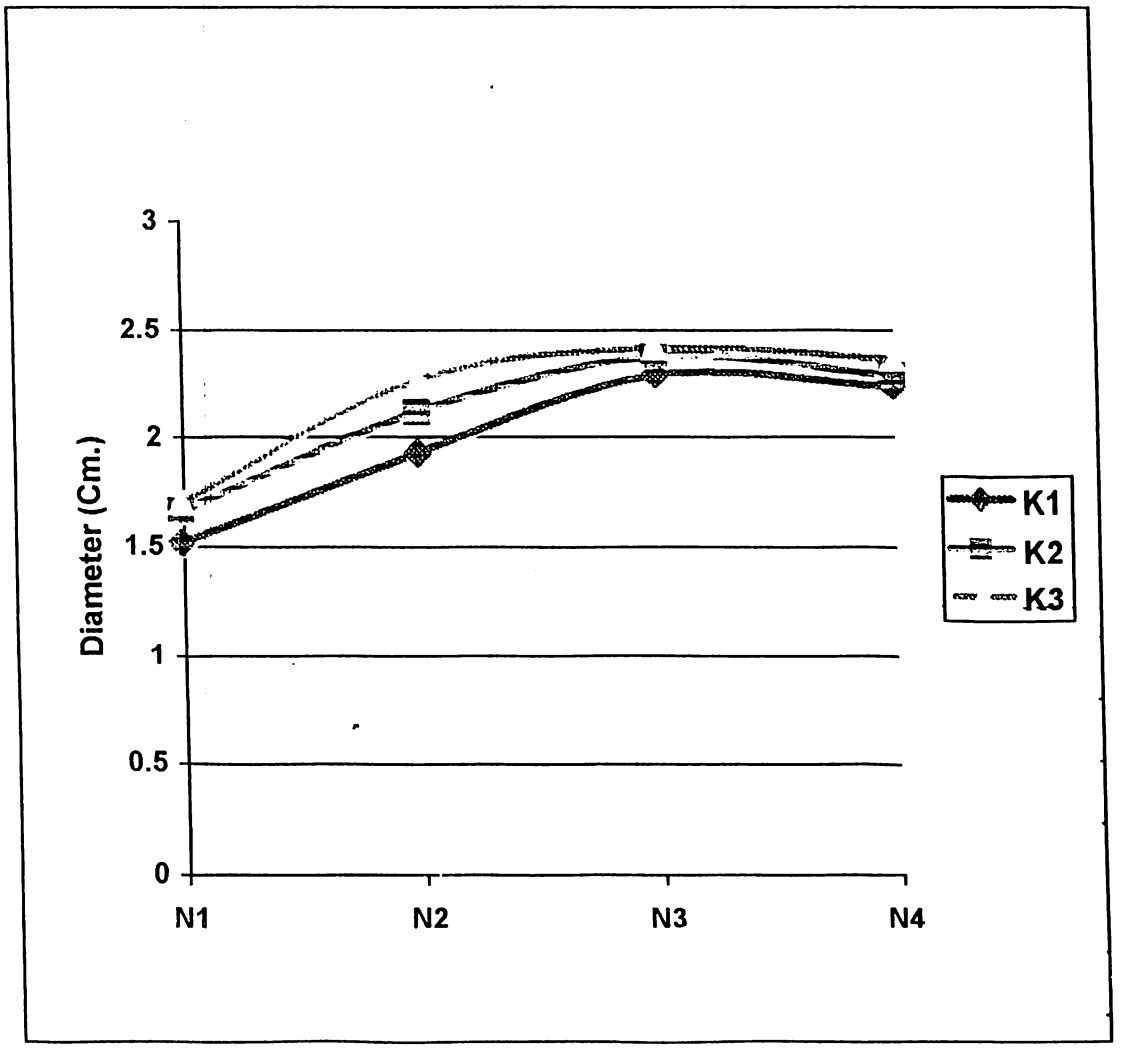
Table-8 : Diameter of bulblets (cm) as influenced by the different levels of nitrogen and potash.

	K_1	K_2	K_3	Mean (N)
N_1	1.51	1.66	1.70	1.62
N_2	1.92	2.11	2.26	2.09
N_3	2.28	2.37	2.41	2.35
N_4	2.23	2.28	2.36	2.29
Mean (K)	1.89	2.10	2.18	

	N	K	N x K
$SE(m)_{\pm}$	0.088	0.076	0.153
$CD_{0.05}$	0.183	0.158	0.317

With each increase in the levels of nitrogen from 60 kg to 120 kg per hectare, the diameter of bulblet correspondingly increased, but with further increase in the levels of nitrogen up to 150 kg per hectare, the diameter of the

Fig.3 : Diameter of bulblet as influenced by different levels of N and K



bulblet suddenly decreased and remained at par with the nitrogen level of 120 kg per hectare. However, maximum diameter of bulblet was observed with N_3 (2.35 cm).

In respect of potash application, with each increase of potash level from 40 kg to 60 kg per hectare, there was corresponding increase in the diameter of bulblet, but with further application of potash @ 80 kg per hectare, the diameter of bulblet increased. However, maximum diameter of bulblet was recorded at K_3 (2.18 cm), which also remained statistically at par with K_2 (2.10 g).

As regards the effect of interaction, the maximum diameter of the bulblet was recorded at N_3K_3, which is also statistically superior than the rest of the treatments except the treatment combinations N_2K_2, N_2K_3, N_3K_1, N_3K_2, N_4K_1, N_4K_2 and N_4K_3, which remained at par with N_3K_3.

4.6 Weight of bulblets

The weight per bulblet was also influenced by the graded levels of nitrogen, potash and their interactions.

From Table-9, it is revealed that with each increase in the levels of nitrogen, from 60 kg to 120 kg per hectare, resulted in the corresponding increase in the weight per bulblet, but further increase in the levels of nitrogen up to 150 kg per hectare, there was correspondingly significant decrease in weight per bulblet. However, the maximum weight per bulblet was recorded with N_3 (3.79g), which was statistically superior than other levels of nitrogen.

Fig.4 : Weight of bulblet as influenced by different levels of N and K

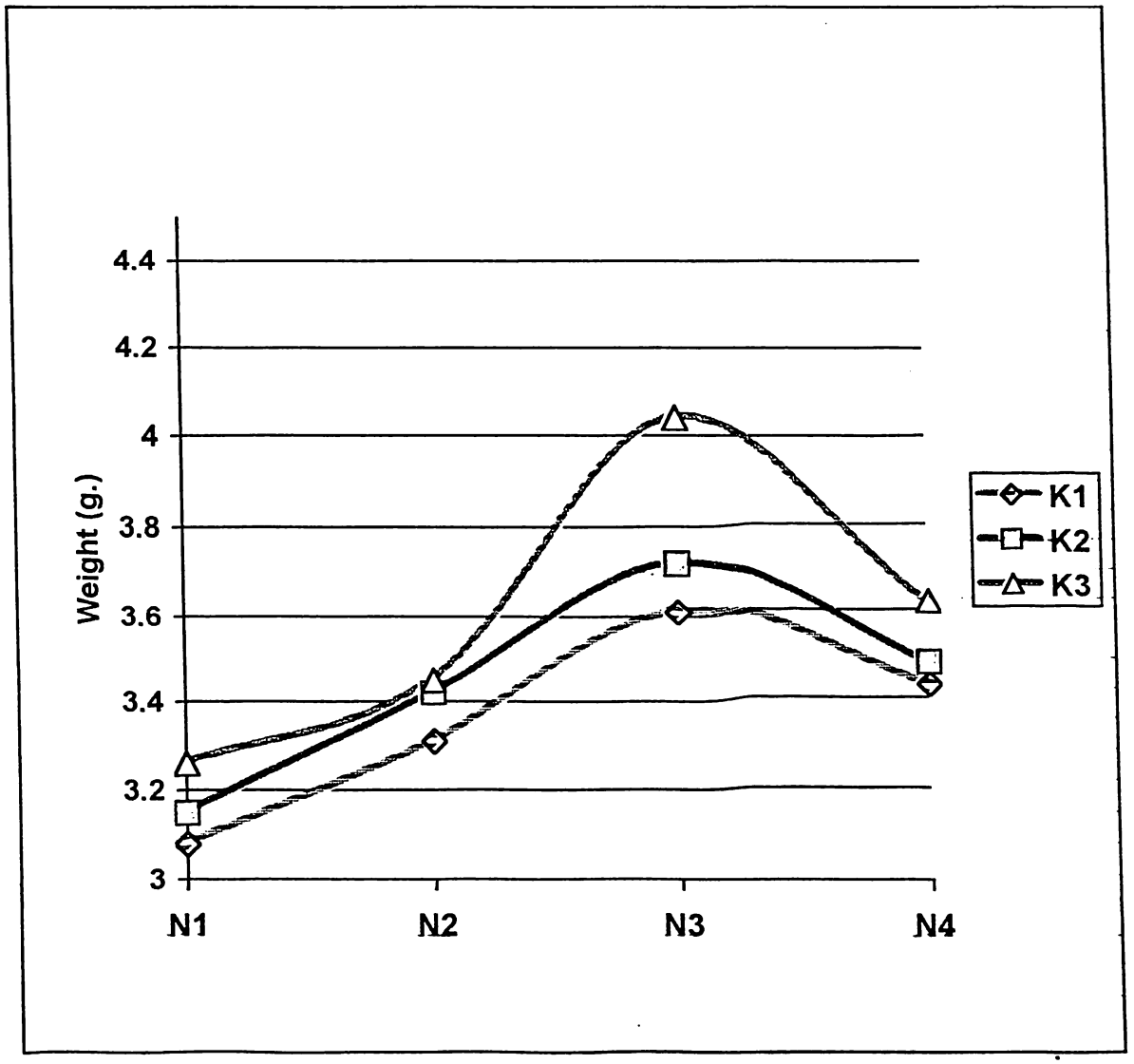


Table-9 : **Weight of bulblet (g) as influenced by the different levels of nitrogen and potash.**

	K_1	K_2	K_3	Mean (N)
N_1	3.08	3.15	3.26	3.16
N_2	3.31	3.42	3.45	3.39
N_3	3.61	3.72	4.04	3.79
N_4	3.43	3.48	3.62	3.51
Mean (K)	3.35	3.44	3.59	

	N	K	N x K
$SE(m)_{\pm}$	0.076	0.066	0.132
$CD_{0.05}$	0.158	0.137	0.273

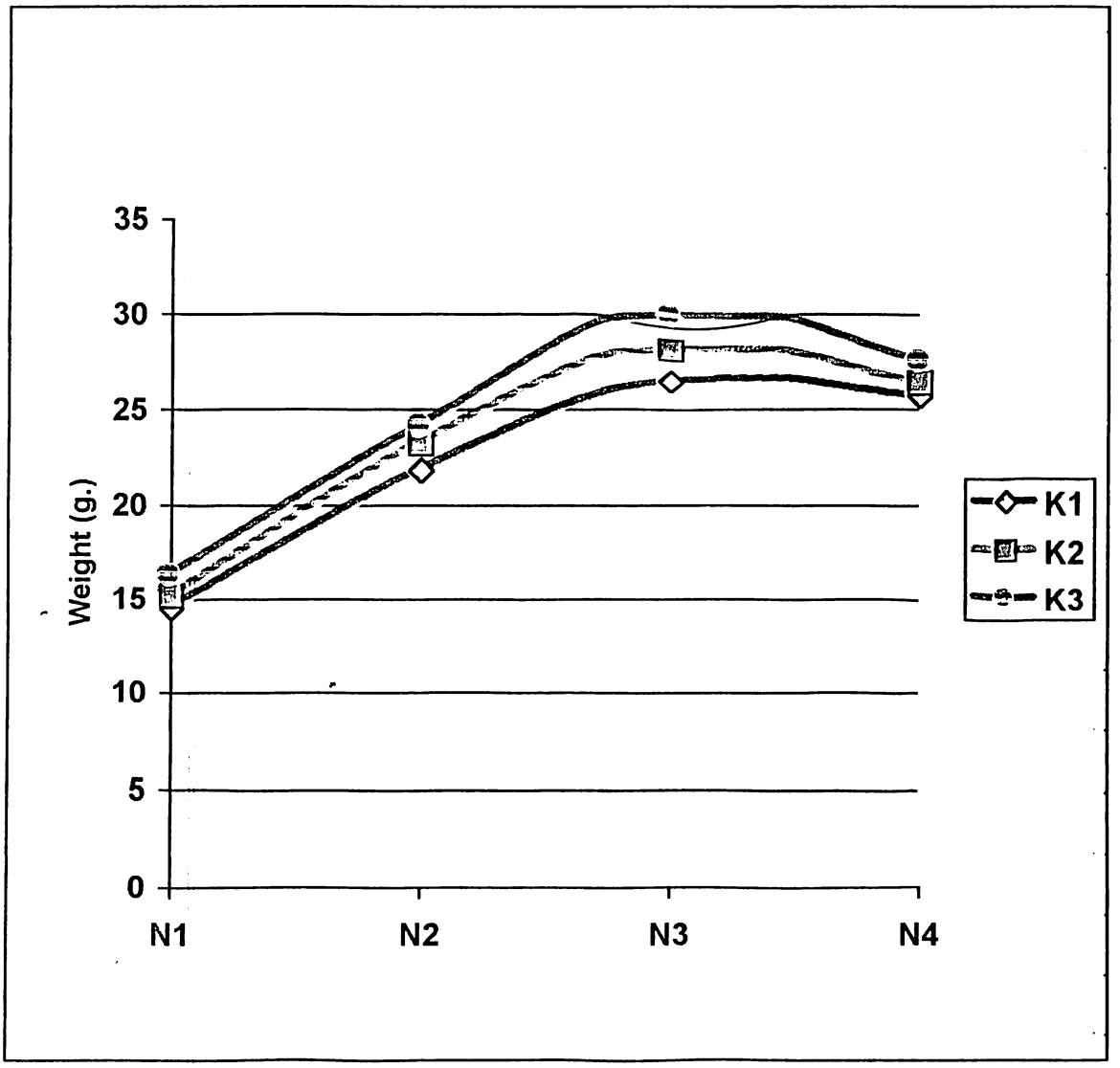
In respect of potash application, with each increase in the levels of potash from 40 kg to 80 kg per hectare, a considerable increase in the weight of the bulblets was observed. However, maximum weight per bulblet was recorded at K_3 (3.59 g), which was statistically superior than other levels of potash, but K_1 and K_2 remained at par with K_3.

As regards to their interactions, maximum weight per bulblet was marked with N_3K_3 (4.04 g), which was statistically superior than all the treatment combinations whereas minimum weight per bulblet was recorded with N_1K_1 (3.08g).

4.7 Weight per clump

It can be clearly indicated from Table-10 that each increase in the level of nitrogen from 60 kg to 120 kg per hectare resulted in the corresponding increase in the weight per clump, but further increase in the level of nitrogen did not bring about any conspicuous change in the weight per clump. Thus, the maximum weight per clump (28.69 g) was recorded when nitrogen @ 120 kg per hectare was

Fig.5 : Weight of clump as influenced by different levels of N and K



applied, which was also found to be statistically superior over all other levels of nitrogen.

Table-10 : Weight of clump (g) as influenced by the different levels of nitrogen and potash.

	K_1	K_2	K_3	Mean (N)
N_1	14.55	15.17	16.32	15.34
N_2	21.84	23.25	24.15	23.08
N_3	26.71	28.64	30.72	28.69
N_4	25.72	26.44	27.59	26.58
Mean (K)	22.20	23.37	24.69	

	N	K	N x K
$SE(m)_{\pm}$	0.241	0.208	0.418
$CD_{0.05}$	0.500	0.433	0.867

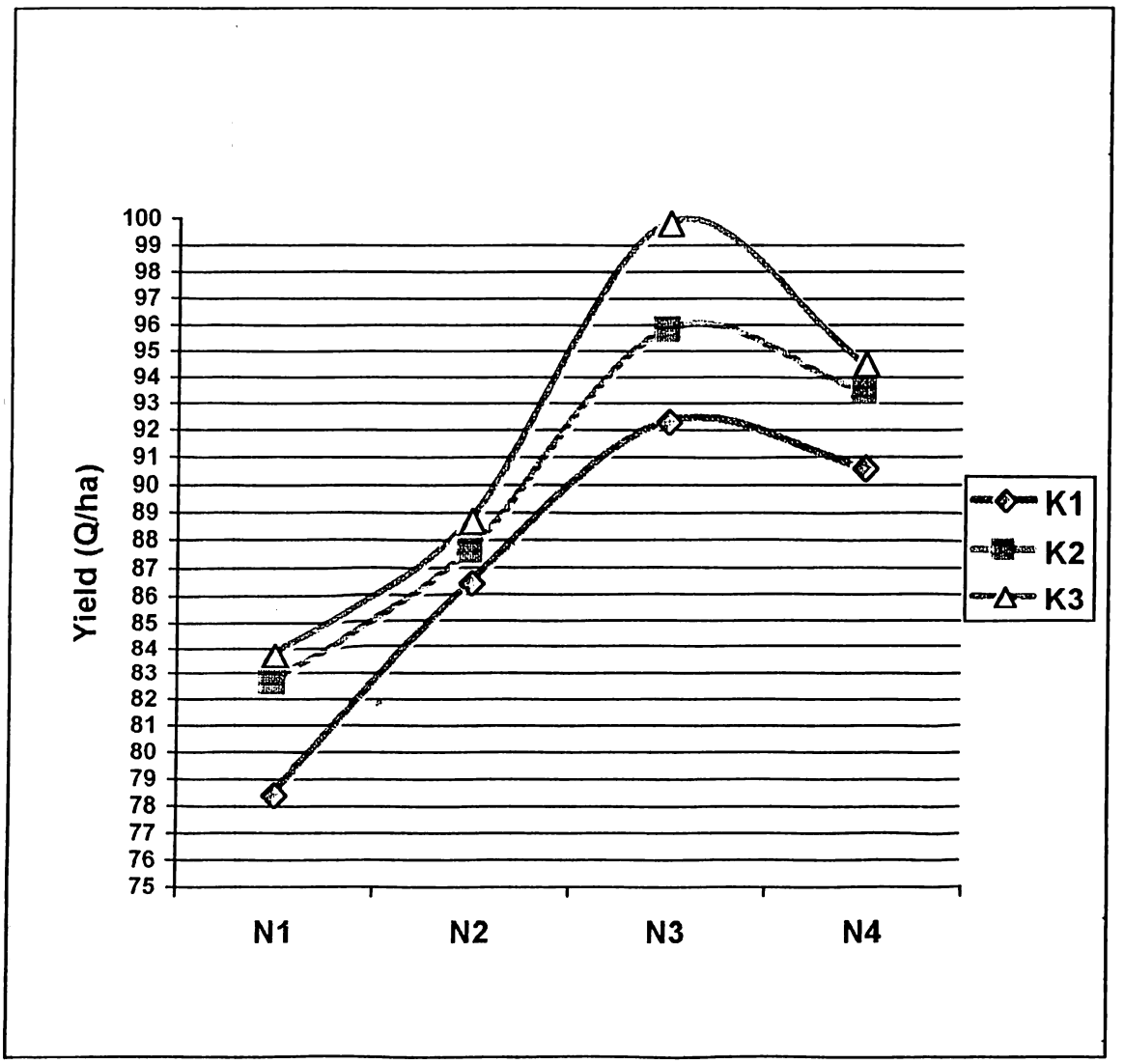
Similarly, with each increase in the levels of potash from 40 kg to 80 kg per hectare, a corresponding increase in weight per clump was noticed and the highest weight per clump (24.69 g) was recorded in K_3 and the lowest was recorded with K_1 (22.20 g).

As per the effect of interaction is concerned, the maximum weight per clump (30.72 g) was recorded when nitrogen @ 120 kg and potash @ 80 kg per hectare were jointly applied (N_3K_3). This was, however, found to be statistically superior than rest of the combinations are taken.

4.8 Yield of onion

A careful review of Table-11 clearly revealed that with each increase in the levels of nitrogen from 60 kg to 120 kg per hectare resulted in correspondingly significant increase in the yield of aggregatum onion. Further increase in the levels

Fig.6 : Yield of onion as influenced by different levels of N and K



of nitrogen beyond 120 kg per hectare significantly reduced the yield. Thus, the highest yield of the onion (95.96 q/ha) was obtained when nitrogen was applied @ 120 kg per hectare.

Table-11 : Yield of onion (q/ha) as influenced by the different levels of nitrogen and potash.

	K_1	K_2	K_3	Mean (N)
N_1	78.4	82.6	83.7	81.56
N_2	86.4	87.6	88.7	87.56
N_3	92.3	95.8	99.8	95.96
N_4	90.6	93.4	94.5	92.83
Mean (K)	86.92	89.85	91.67	

	N	K	N x K
$SE(m)_{\pm}$	0.204	0.177	0.354
$CD_{0.05}$	0.424	0.367	0.734

Likewise, with each increase in the levels of K from 40 kg to 80 kg per hectare, there was correspondingly significant increase in the yield of onion. However, maximum yield of 91.67 q/ha was recorded when potash was applied @ 80 kg per hectare. The effect of interaction between nitrogen and potash also had significantly impact on the yield. The highest yield of 99.8 q/ha was obtained with combined application of N and K @ 120 kg and 80 kg per hectare respectively, which was significantly higher than all those recorded under other treatment combinations studied in the present experiment.

4.9 Total soluble solid (Degree brix) :

It can be seen from Appendix-IX that the total soluble solid (T.S.S.) was influenced significantly with different levels of nitrogen and potash and their interactions.

Fig.7 : Total Soluble Solid (TSS) as influenced by different levels of N and K

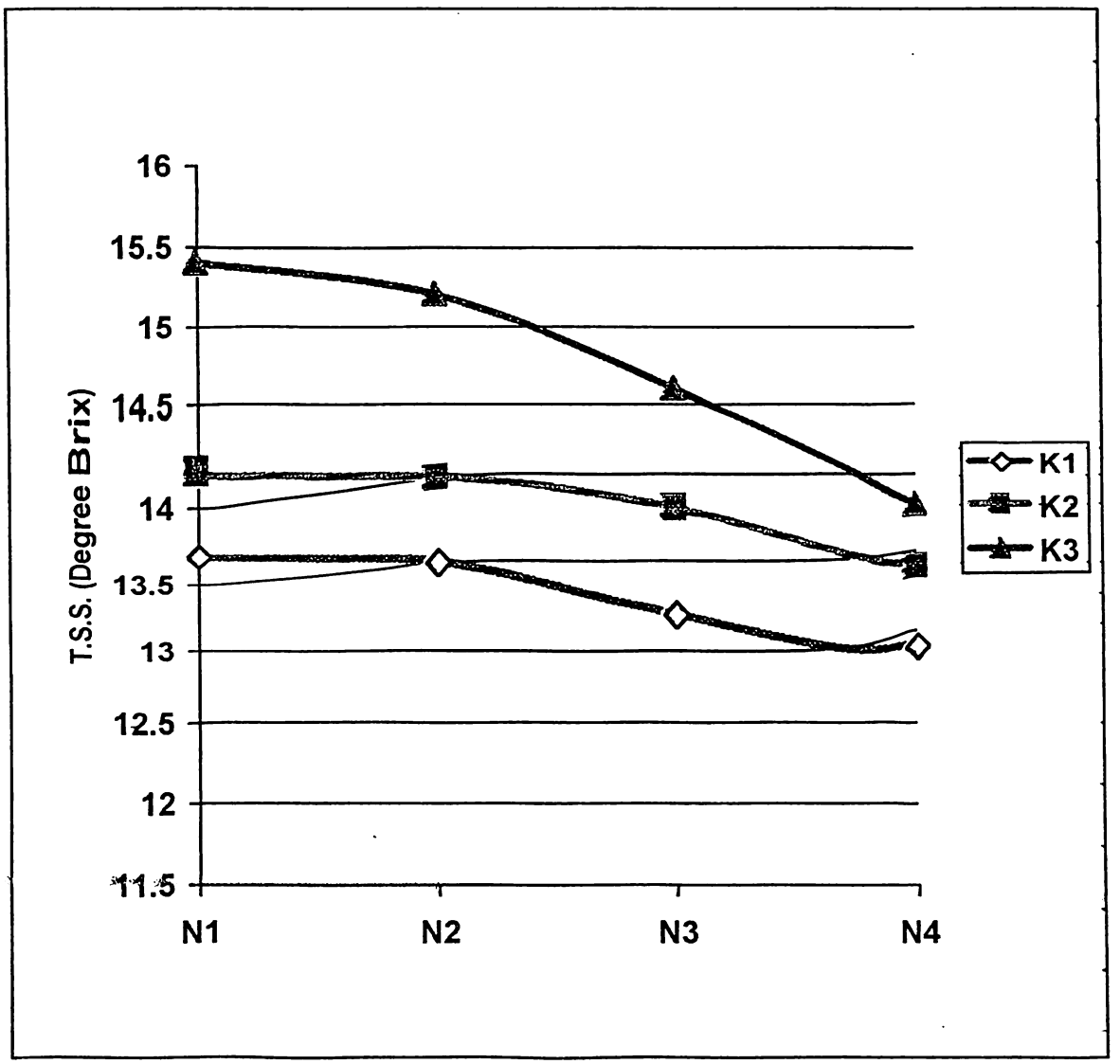


Table-12 : Total soluble solids (Degree brix) as influenced by the different levels of nitrogen and potash.

	K_1	K_2	K_3	Mean (N)
N_1	13.7	14.2	15.4	14.43
N_2	13.5	14.0	15.2	14.23
N_3	13.2	13.8	14.6	13.86
N_4	12.9	13.4	13.8	13.36
Mean (K)	13.32	13.85	14.75	

	N	K	N x K
$SE(m)_{\pm}$	0.122	0.105	0.211
$CD_{0.05}$	0.253	0.219	0.438

The T.S.S. was observed from the above table that it decreased slightly with each increase in the levels of nitrogen. However, maximum brix reading of 14.43° was recorded when nitrogen was applied @ 60 kg per hectare. Likewise, with each increase in K level, there was corresponding increase of T.S.S. and as such maximum T.S.S. of 14.75° brix. was recorded at K_3. As regards to the interaction effect, the highest T.S.S. value was recorded at N_1K_3 (15.4° brix), which was significantly superior than rest of the other combinations. However, N_1K_3 treatment combination also remained at par with N_2K_3 treatment combination.

4.10 Storage study (30 days after harvest)

From Appendix-X, it is clearly observed that the self life of aggregatum onion has been significantly influenced by the application of graded levels of nitrogen, potash and their interactions.

Fig.8 : Storage study (30 days after harvest) as influenced by different levels of N and K

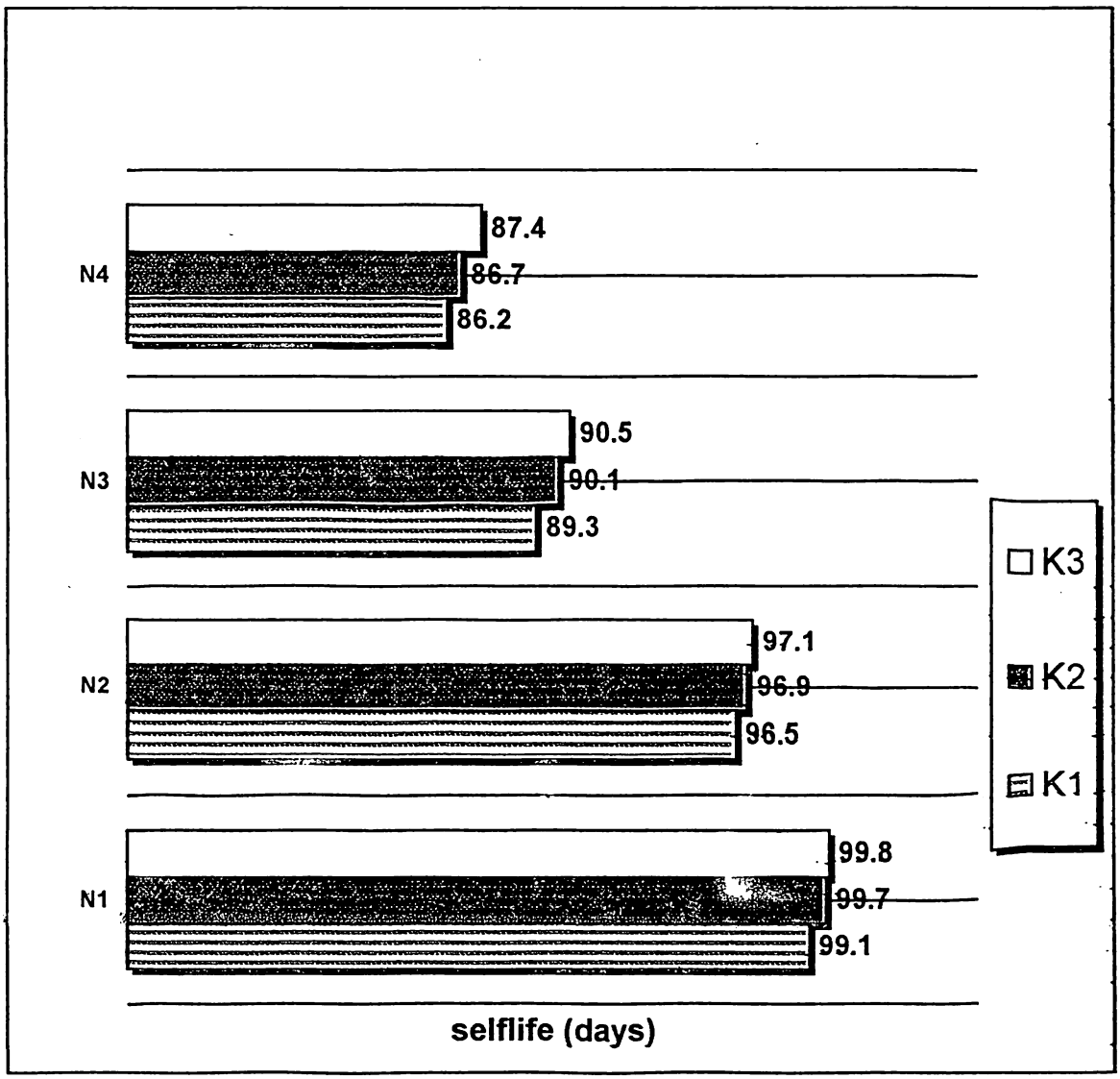


Table-13 : Storage study (30 days after harvest) as influenced by the different levels of nitrogen and potash.

	K_1	K_2	K_3	Mean (N)
N_1	99.1	99.7	99.8	99.53
N_2	96.5	96.9	97.1	96.83
N_3	89.3	90.1	90.5	89.96
N_4	86.2	86.7	87.4	86.76
Mean (K)	92.77	93.35	93.70	

	N	K	N x K
$SE(m)_{\pm}$	0.225	0.195	0.389
$CD_{0.05}$	0.467	0.404	0.808

Each increase in the levels of nitrogen, i.e. from 60 kg to 150 kg per hectare, there was correspondingly significant increase in the spoilage. However, the lowest number of healthier bulblets (86.76) were recorded with N_4, whereas the highest number of healthier bulblets were recorded with N_1 (99.53), which is superior among all the graded nitrogen applied.

Likewise, with each increase in the levels of potash from 40 kg to 80 kg per hectare, there was correspondingly significant increase in self life of aggregatum onion. However, the highest number of healthier bulblets were recovered with K_3 (93.70), which remained at par with K_2 and the lowest was at K_1 (92.77) after 30 days of storing.

As regards the interaction, the maximum healthier bulblets (99.8) was recorded under N_1K_3, which statistically remained at par with N_1K_2 and N_1K_1 after 30 days of storing.

4.11 Storage study (60 days after harvest)

The self life of aggregatum onion has been significantly influenced by the application of graded levels of nitrogen, potash and their interactions.

Table-14 : Storage study (60 days after harvest) as influenced by the different levels of nitrogen and potash.

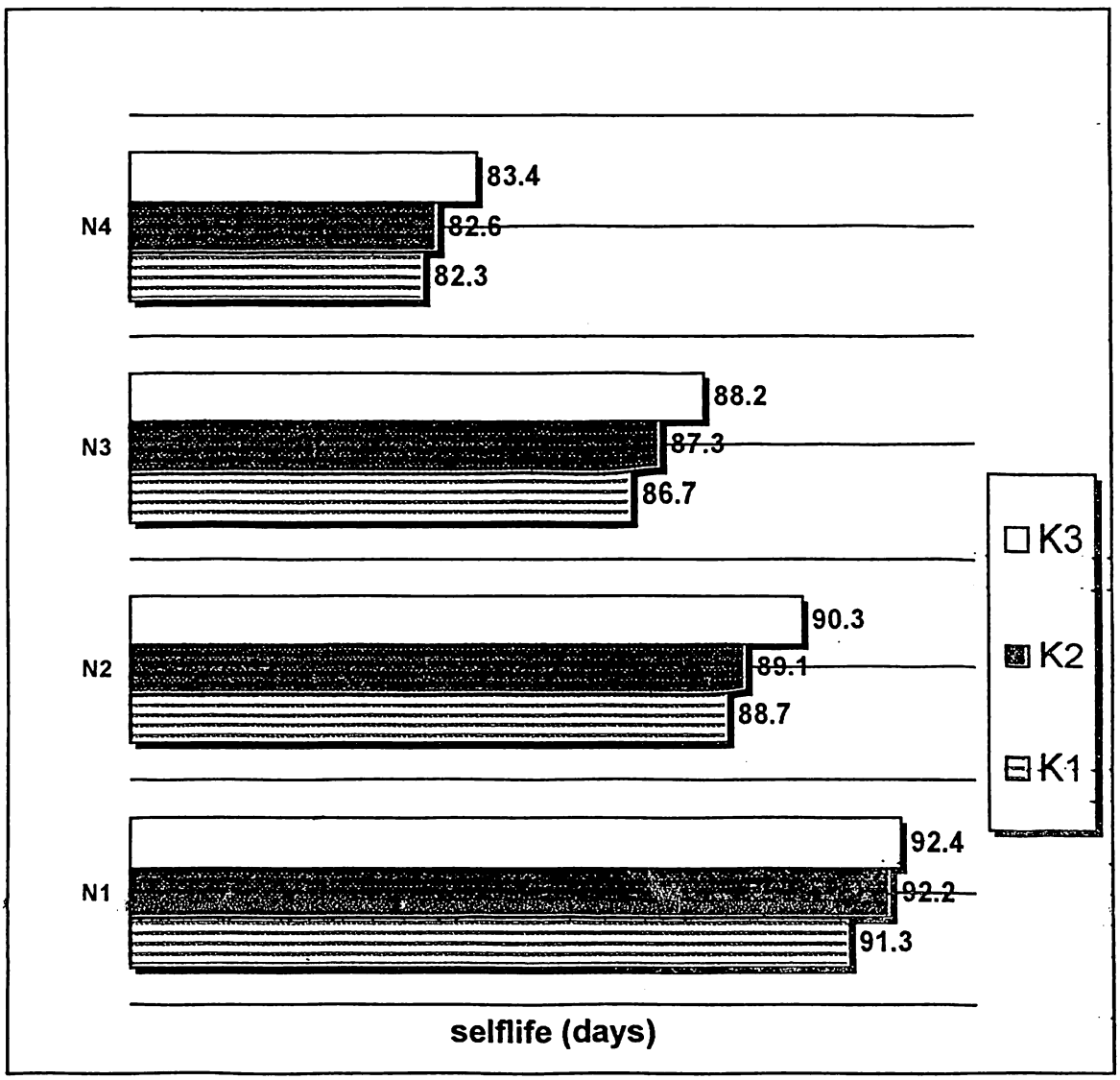
	K_1	K_2	K_3	Mean (N)
N_1	91.3	92.2	92.4	91.96
N_2	88.7	89.1	90.3	89.36
N_3	86.7	87.3	88.2	87.40
N_4	82.3	82.6	83.4	82.76
Mean (K)	87.25	87.80	88.57	

	N	K	N x K
$SE(m)_{\pm}$	0.230	0.176	0.353
$CD_{0.05}$	0.422	0.366	0.732

With each increase in the levels of nitrogen from 60 kg to 150 kg per hectare, the recovery to healthier bulblets was reduced significantly. However, maximum recovery of healthier bulblets was recorded with N_1 (91.96) and the minimum with N_4 (82.76).

Similarly, with each increase in the levels of K from 40 kg to 80 kg per hectare, there was correspondingly significant increase in the self life of aggregatum onion. However, maximum recovery of healthier bulblets were recorded with K_3 (88.57), which was statistically superior among other levels of potash applied.

Fig.9 : Storage study (60 days after harvest) as influenced by different levels of N and K



As regards the interaction, the maximum healthier bulblets were recorded with N_1K_3 (92.4), which was superior than all the other treatment combinations except N_1K_2 and N_1K_1, which remained at par with N_1K_3.

4.12 Storage study (90 days after harvest)

From Appendix-XII, it is revealed that the self life of aggregatum onion has been significantly influenced by the application of graded levels of nitrogen, potash and their interactions after 90 days of storing.

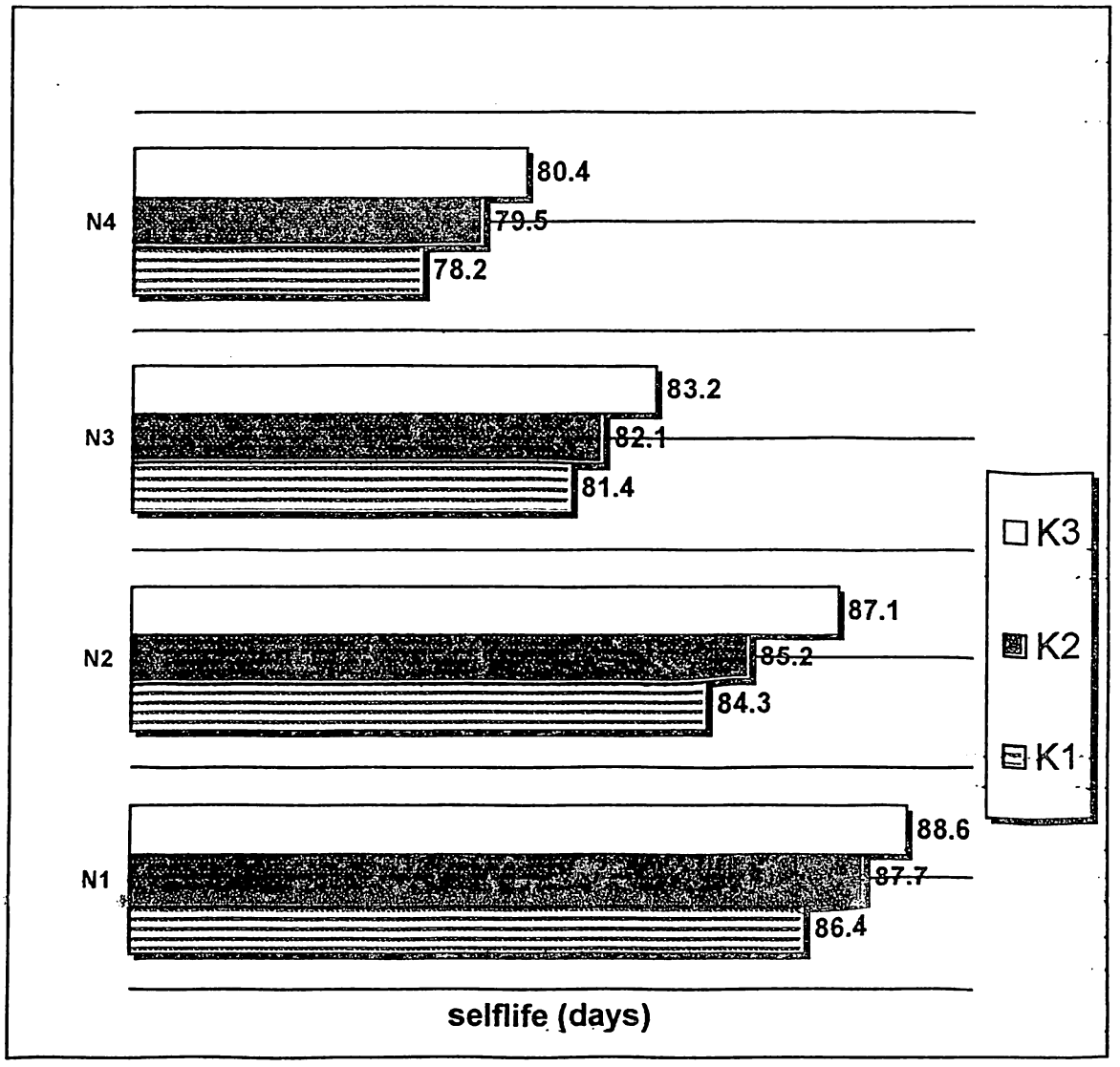
Table-15 : Storage study (90 days after harvest) as influenced by the different levels of nitrogen and potash.

	K_1	K_2	K_3	Mean (N)
N_1	86.4	87.7	88.6	87.56
N_2	84.3	85.2	87.1	85.53
N_3	81.4	82.1	83.2	82.23
N_4	78.2	79.5	80.4	79.36
Mean (K)	82.57	83.62	84.82	

	N	K	N x K
$SE(m)_{\pm}$	0.135	0.117	0.233
$CD_{0.05}$	0.279	0.242	0.484

From the above Table, it is clearly seen that with each increase in the levels of nitrogen from 60 kg to 150 kg per hectare, there was correspondingly significant decrease in recovery of healthier bulblets. However, the highest number of healthier bulblets were recovered at N_1 (87.56), which was superior among all the levels of nitrogen applied. The lowest recovery of bulblets was recorded with N_4 (74.36).

Fig.10 : Storage study (90 days after harvest) as influenced by different levels of N and K



Likewise, with each increase in the levels of potash from 40 kg to 80 kg per hectare, the recovery of healthier bulblets was significantly increased. However, maximum recovery of healthier bulblets were recorded with K_3 (84.82), which was superior than other levels of potash applied.

As far as the interaction was concerned, the maximum healthier bulblets were recovered with N_1K_3 (88.6), which was significantly superior among all the treatment combinations.

4.13 Storage study (120 days after harvest)

It can be marked from Appendix-XIII that the self life of aggregatum onion has been significantly influenced by the application of graded levels of nitrogen, potash and their interactions even after 120 days of storing.

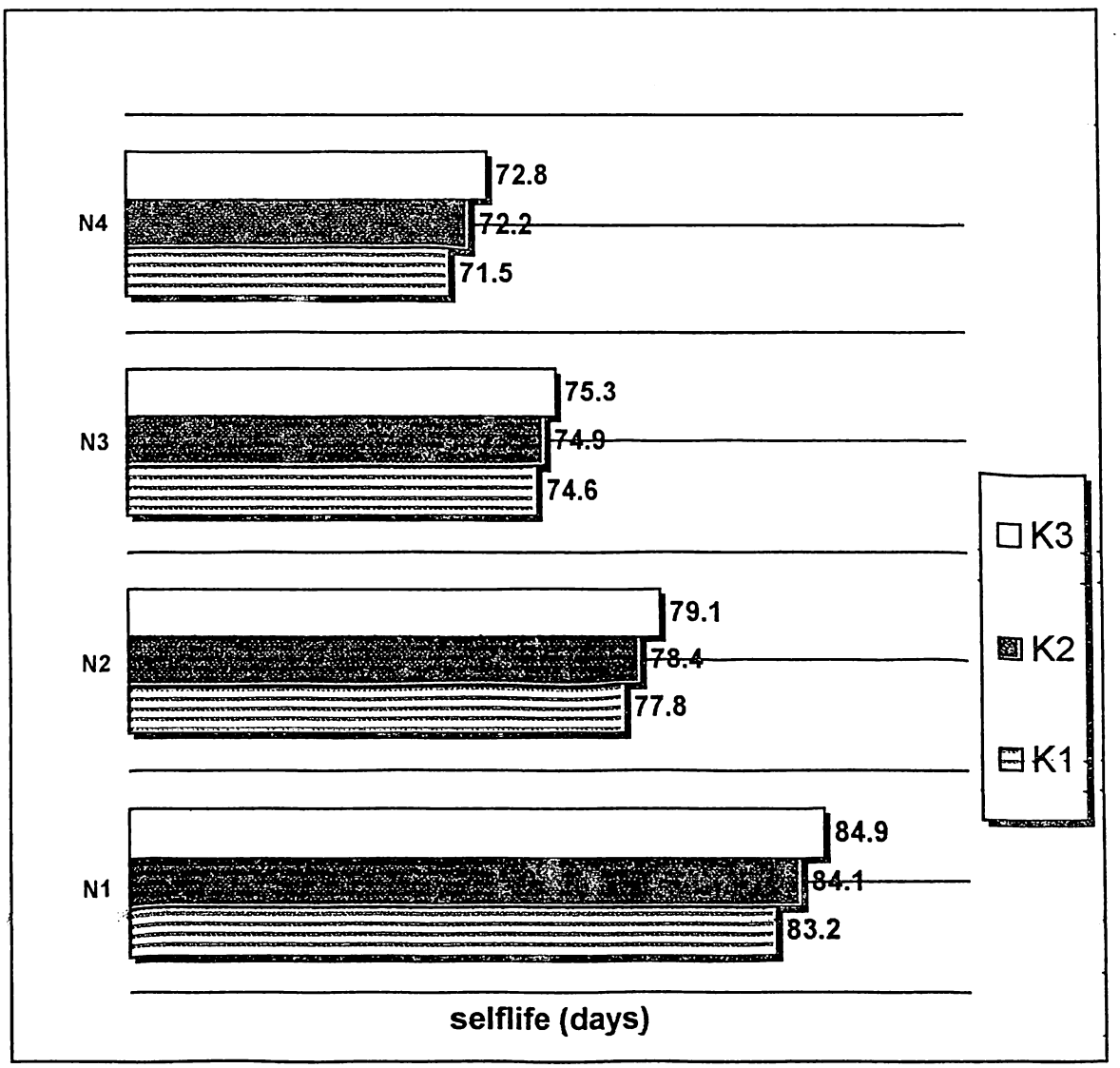
Table-16 : Storage study (120 days after harvest) as influenced by the different levels of nitrogen and potash.

	K_1	K_2	K_3	Mean (N)
N_1	83.2	84.1	89.9	84.06
N_2	77.8	78.4	79.1	78.43
N_3	74.6	74.9	75.3	74.93
N_4	71.5	72.2	72.8	72.16
Mean (K)	76.77	77.40	78.02	

	N	K	N x K
$SE(m)_{\pm}$	0.155	0.134	0.268
$CD_{0.05}$	0.321	0.278	0.556

With each increase in the levels of nitrogen from 60 kg to 150 kg per hectare, there was correspondingly significant decrease in recovery of healthier bulblets. However, the highest number of healthier bulblets were recovered at N_1

Fig.11 : Storage study (120 days after harvest) as influenced by different levels of N and K



level (84.06), which was superior among all the other doses of nitrogen applied. The minimum recovery of bulblets was recorded with N_4 (72.14%).

Likewise, with each increase in the levels of potash application from 40 kg to 80 kg per hectare, there was correspondingly significant decrease in the spoilage and the highest healthier bulblets were recovered with K_3 (78.02), which was superior among other levels of potash applied.

As far as the interaction was concerned, the maximum healthier bulblets were recovered with N_1K_3 (84.9), which proved to be the best among all other treatment combinations taken.

4.14 Storage study (150 days after harvest)

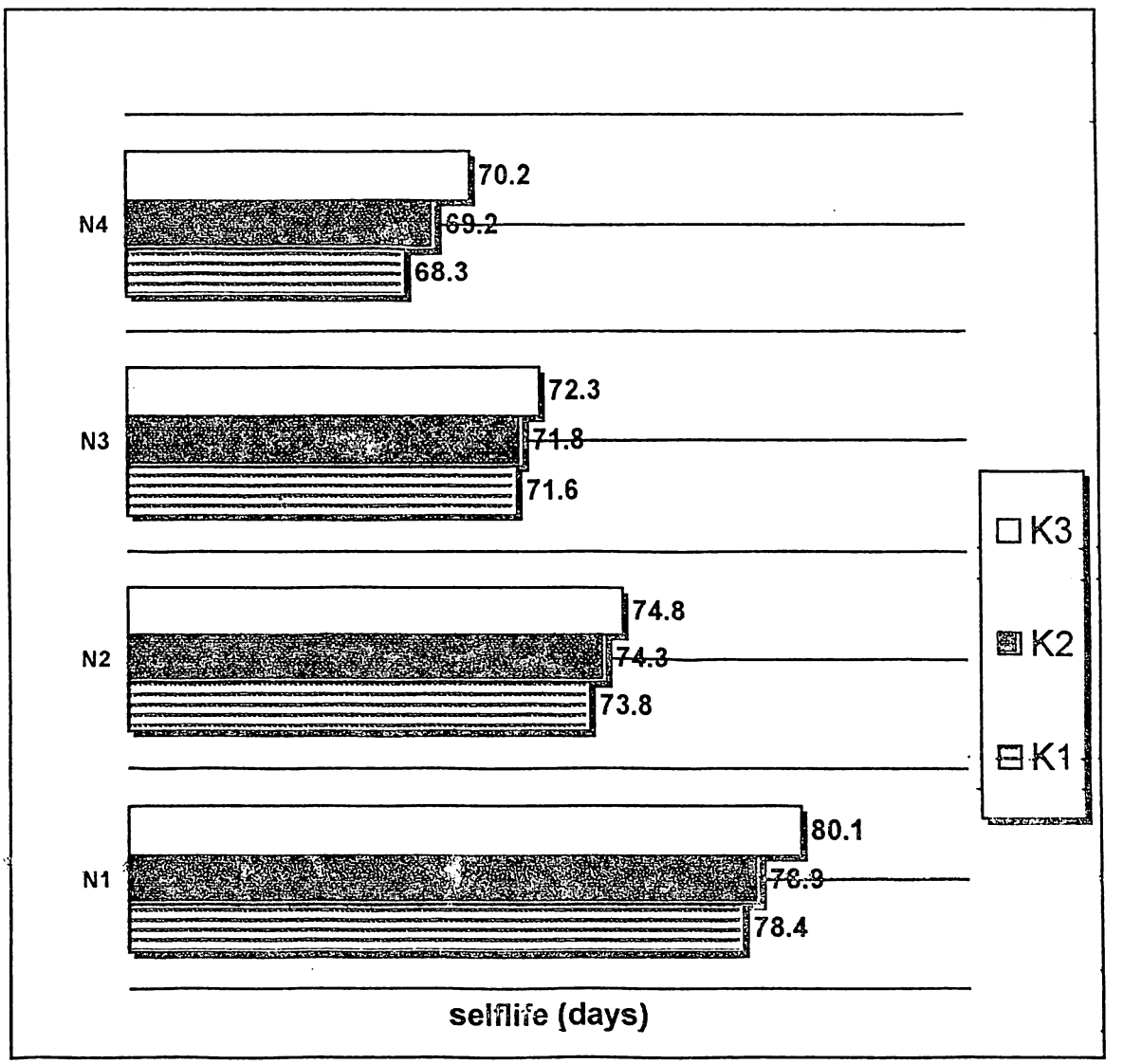
From Appendix-XIV, it is observed that keeping quality of aggregatum onion has been significantly influenced by the application of different levels of nitrogen, potash and their interactions after 150 days of storing.

Table-17 : Storage study (150 days after harvest) as influenced by the different levels of nitrogen and potash.

	K_1	K_2	K_3	Mean (N)
N_1	78.4	78.9	80.1	79.13
N_2	73.8	74.3	74.8	74.30
N_3	71.6	71.8	72.3	71.90
N_4	68.3	69.2	70.2	69.23
Mean (K)	73.02	73.55	74.35	

	N	K	N x K
$SE(m)_{\pm}$	0.191	0.165	0.331
$CD_{0.05}$	0.396	0.343	0.686

Fig.12 : Storage study (150 days after harvest) as influenced by different levels of N and K



With each increase in the levels of nitrogen from 60 kg to 150 kg per hectare, there was correspondingly significant decrease in keeping the quality of aggregatum onion (Table-17). However, the maximum recovery of healthier bulblets was recorded with N_1 (79.13), which was significantly superior among all the levels of nitrogen applied and the lowest recovery with N_4 (64.43).

Likewise, with each increase in the levels of potash from 40 kg to 80 kg per hectare, there was correspondingly significant increase in keeping quality of aggregatum onion. However, the highest recovery of healthier bulblets was marked with K_3 (74.35), which also proved best among all the levels of potash applied.

As far as the interaction was concerned, the highest healthier bulblets were observed on the treatment combination of N_1K_3 (80.1), which also proved to be the best among all the treatment combinations taken.

CHAPTER-V

DISCUSSION

CHAPTER-V

5.0 DISCUSSION

The experiment was carried out to study the effect of nitrogen and potassium nutrition on the growth and yield of multiplier onion brought out many investigating results which have been explained in detail in the previous chapter. In the present chapter, the important results have been discussed with the help of scientific facts and findings of earlier works to confirm the present findings.

5.1 Effect of Nitrogen

The nitrogen nutrition exhibited considerable impact on the growth, development and finally the yield of aggregatum onion as evident from the results presented in the previous chapter. With each increase in the levels of nitrogen

from 60 to 120 kg/ha, a correspondingly significant increase in the yield of onion was recorded, but further increase in the levels of nitrogen (150 kg/ha) resulted in the significant decrease of the yield in onion. The yield attributed characters such as diameter of bulblet, weight per bulblet, weight per clump and number of bulblets per clump were recorded to be maximum under N_3 (120 kg N per hectare). In case of all these characters, the mean values got reduced with further increase in levels of nitrogen beyond 120 kg/ha. Application of 120 kg N per hectare to be the optimum dose for aggregatum onion. The maximum value in respect of growth character of the plant such as plant height and number of leaves per plant were, however, recorded maximum under N_4 (150 kg N per hectare). The excess vegetative growth was absorbed under the higher levels of N probably had an adverse effect on the formation of growth and development of the bulblets and finally on the weight per clump which was reflected in the yield which ultimately resulted in the production of maximum yield.

Further the optimum dose of nitrogen favoured in promoting the growth parameter might be due to the fact that the net assimilation rate of the nitrogen fed plants was accelerated by their increased chlorophyll content and the absorbed nitrogen helped the formation of food reserve due to higher photosynthetic activity.

In respect of storage life, application of N at higher doses proved to be detrimental. With each increase in the levels of N from 60 kg to 150 kg/ha, a correspondingly decrease in the percentage of good and healthy onion bulbs at different stages of storage from 30 days till 150 days was observed which might be due to the fact that application of N at higher levels made the tissues more succulent resulted from a lower rate of transpiration as compared to those with a limited. This reduction is due to low hydrogen concentration and allows greater

swelling of protoplasmic colloids (Ewing and Pearsall, 1929). This nature could not render good self life to onion bulblets. On the 150th day, it was found that maximum bulblets of 179.13 numbers under N_1 were in the marketable condition and this treatment was found to be statistically superior to the rest tried. Maximum loss during storage was observed under N_4. The findings of the present experiments are in agreement with Singh and Batra (1972), Hassan (1977), Henriksen et al. (1987), Palled et al. (1988), Vishnushukla et al. (1989), Pandey and Ekpo (1991), Vissav (1995), Mehla (1996), Vachani (1996) and Kumar et al. (1998).

5.2 Effect of Potash

Like nitrogen, potash nutrition had also a significant effect on growth and development of aggregatum onion.

With each increase in the levels of K from 40 kg to 80 kg/ha, there was correspondingly significant increase in the yield of onion. The maximum values in respect of yield attributing characters such as number of bulblets per clump, diameter of bulblet, weight per bulblet and finally weight per clump were also recorded when K was applied @ 80 kg/ha. The maximum values in respect of height of the plant, number of leaves per plant and fresh weight of the roots were, however, recorded maximum in the highest levels of K tried in the present experiment. The result also indicated application of 80 kg of K per hectare encouraged the root growth of the plant.

Application of K nutrition, however, had a good impact on the storage life of aggregatum onion. With increase in the levels of K from 40 to 80 kg/ha, a correspondingly reduction on the spoilage of onion bulblets was recorded during

the course of storage study. The onion under the highest dose of K was subjected to minimum loss due to spoilage. The research results are concurrence with the findings of Hawthorn (1936), Das and Dhyani (1956), Downs and Carlous (1961), Singh and Kumar (1969), Singh and Dhan[illegible]r (1991), Boloch et al. (1991), Sharma (1992) and Sher (1996).

5.3 Interaction of Nitrogen and Potash

The combined effect of nitrogen and potassium also exhibited very meaningful impact on the performance of aggregatum onion crop where the maximum yield was recorded with N_3K_3 (99.8 q/ha) which surpassed all the yield of other combinations significantly. The minimum yield of 78.4 q/ha was recorded with N_1K_1. The maximum yield of aggregatum onion was due to the optimum application of N and K fertilizer, thereby by utilising all the nutrients in time and expressed for higher yield on the other hand higher levels of N and K exhibited more vegetative growth as the higher nutrient levels were mostly used for the physiological expressions of plant rather in its yield attributing characters.

As regards the effect of nitrogen and potash nutrition on the storage life of the aggregatum onion is concerned. The present result clearly revealed that lower levels of N and higher levels of K were more useful in extending the self life of aggregatum onion. Thus, it was seen that minimum spoilage loss during different stages of storage after the harvest was observed under the lowest dose of N (60 kg/ha) and highest dose of K (80 kg/ha). The findings of the research results are concurrence with Malachowski (1974), Rahman et al. (1976), Flones (1977), Madan and Sandhu (1983), Subbiah et al. (1996), Duque et al. (1989), Jayabharathi (1989) and Katwale and Saraf (1994).

CHAPTER-VI

SUMMARY AND CONCLUSION

CHAPTER-VI

6.0 SUMMARY AND CONCLUSION

An experiment entitled "**Effect of nitrogen and potassium nutrition on the growth and yield of multiplier onion (*Allium cepa* var. *aggregatum*)**" was carried out at the Horticulture Research Station, College of Agriculture, Orissa University of Agriculture and Technology (OUAT), Bhubaneswar. In this experiment, different levels of nitrogen and potash were tried, with an objective to standardise the nutrient levels (N and K) for aggregatum onion. Here, an attempt has been made to summarise the salient findings of the experiment.

A wide range of variation was marked by the application of nitrogen with respect to growth, development and finally yield of aggregatum onion. With increase in the level of nitrogen from 60 kg to 120 kg per hectare, there was

considerable increase in the yield, but further increase of nitrogen beyond 120 kg/ha reduced the yield considerably. All the observations recorded in relation to yield and its yield attributed characters, clearly indicated the superiority of N_3 (120 kg/ha) treatment to other treatments except height of the plant and number of leaves per plant which is maximum at N_4 (150 kg/ha).

With each increase in the level of potash from 40 kg to 80 kg per hectare, a correspondingly significant increase in the yield of aggregatum onion was observed under K_3 (80 kg/ha). The highest value relating to yield attributing characters like number of bulblets per clump, diameter of bulblets, weight per bulblets and finally weight per clump were recorded to be maximum when potash was supplied @ 80 kg/ha. This clearly indicates the superiority of K_3 (80 kg/ha) over all the levels of potash tried.

As regards to the aggregatum, both the factors interacted significantly to give the highest yield and yield attributing characters, when 120 kg of 'N' along with 80 kg/ha of potash were applied to plants. This very treatment (N_3K_3) was found to be the best as compared to all other treatment combination.

As regards the effect of nitrogen and potassium nutrition on the storage behaviour of aggregatum onion is concerned, the results clearly revealed that lower level of nitrogen and higher level of potash were useful in extending the self life of onion. Thus, it was seen that minimum spoilage during different stages of storage after harvest was observed under the lowest dose of nitrogen (60 kg/ha) and highest dose of potash (80 kg/ha).

A careful review of the results in the present study clearly indicated that combined application of 120 kg N and 80 kg K to a hectare of land was the best

treatment to obtain good yield of aggregatum onion. This result, of course, offers the scope to continue the experiment with still higher doses of potash to get conclusive result. As regards the storage behaviour of onion, minimum spoilage was marked in the bulbs obtained from the plots which received 60 kg N along with 80 kg K, the lowest and highest doses of the respective nutrients tried in the present study. This result reveals that application of nitrogen appears to be detrimental for extending self life of onion bulbs whereas potash appears to be useful for the purpose but under any circumstances one can not afford to neglect the application of nitrogen nutrients in onion production. Therefore, one must come to a compromising point to make judicious use of N and K fertilizer where a sustainable yield could be obtained with a reasonable self life of the bulbs so as to make commercial onion production - a profitable venture.

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APPENDICES

APPENDICES

APPENDIX-I : Height of the plant (cm) as influenced by different levels of nitrogen and potash nutrition.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F Value
Replication	2	0.398	0.199	2.54
Treatment	11	133.018	12.093	153.97
N	3	58.857	19.619	249.80
K	2	61.648	30.824	392.47
N x K	6	12.513	2.086	26.55
Error	22	1.728	0.079	
Total	35	135.145		

APPENDIX-II : Number of leaves per plant as influenced by different levels of nitrogen and potash nutrition.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F Value
Replication	2	0.668	0.334	2.72
Treatment	11	88.397	8.036	65.48
N	3	54.943	18.314	149.24
K	2	30.470	15.235	124.14
N x K	6	2.984	0.497	4.05
Error	22	2.700	0.123	
Total	35	91.766		

APPENDIX-III : Fresh weight of roots (g) per ten number of plants as influenced by different levels of nitrogen and potash nutrition.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F Value
Replication	2	0.036	0.018	0.53
Treatment	11	15.234	1.385	41.55
N	3	6.057	2.019	60.58
K	2	8.687	4.344	130.32
N x K	6	0.490	0.082	2.45
Error	22	0.733	0.033	
Total	35	16.003		

APPENDIX-IV : Number of bulblets per clump as influenced by different levels of nitrogen and potash nutrition.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F Value
Replication	2	0.132	0.066	0.65
Treatment	11	61.028	5.548	54.78
N	3	59.768	19.923	196.71
K	2	1.095	0.548	5.41
N x K	6	0.165	0.027	0.27
Error	22	2.228	0.101	
Total	35	63.388		

APPENDIX-V : Diameter of bulblet (cm) as influenced by different levels of nitrogen and potash nutrition.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F Value
Replication	2	0.012	0.006	0.17
Treatment	11	3.231	0.294	8.31
N	3	2.944	0.981	27.75
K	2	0.238	0.119	3.36
N x K	6	0.049	0.008	0.23
Error	22	0.778	0.035	
Total	35	4.021		

APPENDIX-VI : Weight of bulblet (g) as influenced by different levels of nitrogen and potash nutrition.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F Value
Replication	2	0.011	0.006	0.22
Treatment	11	2.274	0.207	7.93
N	3	1.834	0.611	23.44
K	2	0.340	0.170	6.52
N x K	6	0.100	0.017	0.64
Error	22	0.574	0.026	
Total	35	2.859		

APPENDIX-VII : Weight per clump (g) as influenced by different levels of nitrogen and potash nutrition.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F Value
Replication	2	0.618	0.309	1.18
Treatment	11	970.693	88.245	337.44
N	3	928.085	309.362	1182.97
K	2	37.348	18.674	71.41
N x K	6	5.260	0.877	3.35
Error	22	5.753	0.262	
Total	35	977.064		

APPENDIX-VIII : Yield of onion (q/ha) as influenced by different levels of nitrogen and potash nutrition.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F Value
Replication	2	0.010	0.005	0.03
Treatment	11	1241.302	112.846	598.83
N	3	1077.184	359.061	1905.39
K	2	138.781	69.391	368.23
N x K	6	25.337	4.223	22.41
Error	22	4.146	0.188	
Total	35	1245.438		

APPENDIX-IX : Total soluble solids ($^{\circ}$ Brix) as influenced by different levels of nitrogen and potash nutrition.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F Value
Replication	2	0.031	0.016	0.23
Treatment	11	19.266	1.751	26.24
N	3	5.926	1.975	29.59
K	2	12.463	6.232	93.36
N x K	6	0.877	0.146	2.19
Error	22	1.468	0.067	
Total	35	20.766		

APPENDIX-X : Storage study of 100 bulblets after 30 days of storing as influenced by different levels of nitrogen and potash nutrition.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F Value
Replication	2	0.135	0.068	0.30
Treatment	11	952.031	86.548	379.23
N	3	946.212	315.404	1382.02
K	2	5.281	2.641	11.57
N x K	6	0.538	0.090	0.39
Error	22	5.021	0.228	
Total	35	957.188		

APPENDIX-XI : Storage study of 100 bulblets after 60 days of storing as influenced by different levels of nitrogen and potash nutrition.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F Value
Replication	2	0.438	0.219	1.17
Treatment	11	419.167	38.106	203.75
N	3	407.604	135.868	726.46
K	2	10.625	5.313	28.40
N x K	6	0.938	0.156	0.84
Error	22	4.115	0.187	
Total	35	423.719		

APPENDIX-XII : Storage study of 100 bulblets after 90 days of storing as influenced by different levels of nitrogen and potash nutrition.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F Value
Replication	2	0.047	0.023	0.29
Treatment	11	385.047	35.004	428.57
N	3	353.158	117.719	1441.29
K	2	30.401	15.201	186.11
N x K	6	1.488	0.248	3.04
Error	22	1.797	0.082	
Total	35	386.891		

APPENDIX-XIII : Storage study of 100 bulblets after 120 days of storing as influenced by different levels of nitrogen and potash nutrition.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F Value
Replication	2	0.302	0.151	1.39
Treatment	11	718.656	65.332	602.54
N	3	708.740	236.247	2178.83
K	2	9.115	4.557	42.03
N x K	6	0.802	0.134	1.23
Error	22	2.385	0.108	
Total	35	721.344		

APPENDIX-XIV : Storage study of 100 bulblets after 150 days of storing as influenced by different levels of nitrogen and potash nutrition.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F Value
Replication	2	0.313	0.156	0.95
Treatment	11	489.771	44.525	271.78
N	3	477.493	159.164	971.55
K	2	10.646	5.323	32.49
N x K	6	1.632	0.272	1.66
Error	22	3.604	0.164	
Total	35	493.688		