# GENETIEAG צTTLTMIES IN OFILM PGFPY 

 (Papaver Somniferum Linn.)
## THESIS

Submitted to the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur in partial fulfilment of the requirements for the Degree of

> DOCJOR OF \&JZSLOSOPGUY g式 cIGRYCULJTHR
( PLANT BREEDING AND GENETICS )

## By

KrisRan Bihari Nigam

## DEPARTMENT OF PLANT BREEDING AND GENETICS

 JAWAHARLAL NEHRU KRISHI VISHWA VIDYALAYACOLLEGE OF AGRICULTURE
JABALPUR, M.P.
1982


## CERTIFICATE I

This is to certify that the thesis entitled "Ganatical studies in Opium Poppy (Papavar sannifarum Linn.)" submitted in partial fulfilment of the requisaments for the dagras of DUCTOR UF PHILOSOPHY IN AGRICUL. TURE of the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, is a record of the bonafide research work carried gut by Sori KRISHAh BIHARI NIGAN under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director ap Instructions.

No part of the thesis has been submitted for any other degree or diploma (certificate ausrdad etc.) or hes been published/publishad part has been fully acknowledged. All the assistance and help received during the course of the investigations have bean duly acknowledged by him.


THESIS APPROVED BY THE STUDENTS ADVISORY CDPHITTEE
Chairman (Dr. S.P.Eingh)


Member (Dr. S.S.Baghe1)

Member (Dr. A.Su日hagiri)

Member (DE* S.M.Sharma)


Number
(Dr. S.K.fiao)
S. Kolerw ara

## CERTIFICATE II

This is to certify that the thesis untitled "Ganetical studies in Opium Poppy (Papavar somnifarum Linn.)" submitted by Shri KRISHAH EIHARI NIGAM ta the J.N. Krishi Viahwa Vidyalaya, Jabalpur, in partial fulfilment of the requirements for the degree of DUCTUR of PHILOSOPHY in the Department of Plant trading and Genetics, has bean appravad by the Student's Advisory Committee and External Examiner (a) after an oral examination of the same.
(ir. B.p. Pond (ya)


## ACKNOWLEDGEMENTS

Indead, it givas ma groat plaanura to axprass my daep sanss of gratituda and indebtadness ta my teacher Or. S.p.Singh, K.Sc.(Ag.), Ph.D.(IARI), University Professar and Head, Departaent of Plant Ereading and Genatics, J.N. Krishi Vishwa Vidyalaya, Jabalpur, for his Isarned magnanimous guidance, precious suggestions, constructive criticiam and ever helping attitude throughout the period of investigation and above all, immense encouragenent raceived Prom him during entire period of this atudy and for timely preparation of this manuscript.

I Peel plasaure in thanking Dr.S.8.Baghel, Droh. Sashagiri. Dr. S.M.Sharma and Dr. S.K.Rao menbers of my Advisary Committas and to Dr. A.R.Dabolkar, Dr.A.froSawant and Dr. C.E.Singh Por their valuabla suggestion, assistance and constant haip ducing the course of the atudias and preparation of manuscript .

My prafound and sincerg thanks are due ta Dr.k.L. Dabral, Sarvshri N.K.Jain(Pathology), V.k.Shrivastava, R.C.Mishra, M.C.Chaurasia, Dr. R.K.Tugnawat, Dr.5.V.K.presad, Dr. G.S.Duivadi, Dr.Panchratan, N.S.Sipani, K.K.shah, Uijay Pradhan and Ur. Harish Pradhan, far their constant helpp suggestians and stimulating inspiratians during the period of study.

1 an also highly thankful to Hessrs G.S.fawat, B.P.Agrwal, N.K.Jain(Agronomy), N.R.Janley, G.K.Saura, DeA.Khan Par their kind cooperation, help and assintance randered to na during the caurse of present investigation.

I an thankful to Shri S.C. .fiupta for excellent, earoful and tinely typing of thasis.

I an grateful to Dr.il.p.Singh, Director of Instructions DroS.N.Dubey, Director of Research Services, Dr. V.N. Shroff, Associate Director of Research. Dr. Rajandra Gupta, Project Coordinator (M\&AP), ICAR and JNKUV, Jabalpur for providing the necessary facilities during the period of study

It is my most pleasant duty, to express my gratitude and humble regards to my father, late Sheri Keshorai Wigan and ta my mother Sit. Anandibai whose blessings, inspired me to enter into the present investigation.

Ny thanks are also dup to my children, Smita, Sarika and Sunil who endured all the sacrifice and hardship ungrudgingly.Indead, last but not the least, I am highly thankful to my wifi Mrs. Kugun Nigan, tho gave an inspiration, unfailing help owing to which I could succeed in this endeavour .

(KRISHAN BIHARI NILAM)
Chapter Page
1 INTRODUCTION ..... 1
2 REVIEW UF LITERATURE ..... 52.1
Variatal impravement, selection and correlations ..... 5
2.22.3
Heterasis in intra-spacific crosses6
Heterosis in interaspecific crosses ..... 10
2.4 Induced variation ..... 12
2.5
Combining ability and gana action ..... 12
3MATERIALS AND METHODS15
3.13.2Geographical location15
Geology ..... 15
3.3 Ci1mato ..... 15
3.4 Agricultural aperationa ..... 16
3.5 Experimental material ..... 17
3.5 .1 Parente ..... 17
3.5 .2 Hybrids ..... 18
3.5 .3 Enviranments ..... 19
3.5 .4 Layout and dasign ..... 20
3.5 .4 .1 Treatmants ..... 20
3.5 .4 .2 Design ..... 20
3.5 .4 .3 ..... 20
Plot aiza
3.5.4.4 ..... 20
3.6 Sampling ..... 20
3.7 Dbservation ceaarded ..... 20

| 3.7 .1 | Height of plant | 20 |
| :---: | :---: | :---: |
| 3.7 .2 | Leaf area | 20 |
| 3.7 .3 | Sten diameter | 21 |
| 3.7 .4 | Number of capsula/plant | 21 |
| 3.7 .5 | Capsule size | 21 |
| 3.7 .6 | Number of stigmatic rays/ capsula | 21 |
| 3.7 .7 | Upium yield/plant | 21 |
| 3.7 .1 | Seed yislv/plant | 21 |
| 3.7 .9 | Husk yielu/plant | 21 |
| 3.7 .10 | Number of upfective, Jancing/ capaule | 21 |
| 3.7 .11 | Maxphina percentage | 22 |
| 3.8 | Scatiatical amalysis | 23 |
| 3.8 .1 | Testing the signipicance of genokypic diffasefice in each enviranment | 23 |
| 3.8 .2 | Testing the significance of genozypic dipferences(nver enviranaents) | 23 |
| 3.8 .2 .1 | Replicatad data | 23 |
| 3.8 .2 .2 | Non seplicated data | 24 |
| 3.8 .3 | Combining ability analysia | 25 |
| 3.8.3.1 | Combining ability analysia in aach envisonment | 25 |
| 3.8 .3 .1 .1 | Eetimation of sum of aquares | 25 |
| 3.3 .3 .7 .2 | AnOVA | 25 |
| 3.3 .3 .1 .3 | Estimetion of gea efiests | 25 |

## Chapter

Page


## Chapter

Page 58
4.5 .1
4.5 .2
4.5 .3
4.5 .4
4.6
4.6 .1
4.6 .2
4.6 .3
4.6 .4
4.7

Per se performance
Heterosis 58
Ca efpects 58
Sca epfects 62
Huaban2: of capsules/plant 62
Per se perforgance 62
Heterasis 64
Gea affects 64
Sca effects 69
Capsule size 69
Par se performance 70
Heterosis 70
Gce appects 70
Sca affacts 75
Number of stigmatic rays/capsula 80
Per se performance 80
Hetarazis 80
Gca epfects 80
Sca eppecto 85
Cpium yiald/plant 86
Par sa perfarmance 86
Hetercois 86
Gea eppacts 90
Sca effacta 95

## Chaptar

| 4.10 | Seed yieldplant | 97 |
| :--- | :--- | :--- |
| 4.10 .7 | Per se parpormance | 97 |
| 4.90 .2 | Haterosis | 99 |
| 4.10 .3 | Gea effects | 99 |

A.10.4 Sca eppects 105
4.11 Huek yield/plant 107
4.11 .1

Par se perfurmance
107
4.11 .2

Heterosis 107
4.11 .3

Gat erfecis 109
4.11 .4

San effects 116
4.12
Number of effectiva lancing/.
capsule
4.12.1 Far be pesformance 117
4.12.2 Hetsanaia 119
4.12.3 Gea 日ppecte 119
4.12.4 Saa effecte 125
4. 13 Mospivife percentage 127
4.13.1 Par as performante 127
4.13 .2

5
DTSCUSSI UN
131

6

SUPHATY, GOMCLUSION AND SUGGESTIUNS FOA FURTHEA WORK

REFLBLELES

## LIST UF TABLE

Table Na. Title of the Table Pago
AWOVA RBD in all enviranments ..... 31
ANOUA RED (over environments) ..... 32
ANDVA RBD for morphins percentage ..... 35aNOVA Por combining ability analysisin all environments36
ANUVA Por combining ability analysis (over enviranments) ..... 37
Per se performance for plant height ..... 39
Heterosis for plant haight ..... 40
Gea and sca effects for plant haight in E1 ..... 41
Gea and sea effects for plant height in E2 ..... 43
Gea and sca affects for plant height in E3 ..... 44
Gea and sea effects for plant height in E4 ..... 45
Gea and sca effacts por plant hoight (over environments) ..... 46
Per se performance for laf araa ..... 48
Hetazosis for leaf araa ..... 50
Gea and sca effacta Por leap area in E1 ..... 51
Gea and sea affects for laaf araa in E2 ..... 52
Gea and sea affects Por leap area in E3 ..... 53
Gea and sca affacts for leaf area in E4 ..... 54
(ova and aca appects por leap area (over environmenta) ..... 56
Par sa performance Par stendiamater ..... 59
Haterasis Por stamdiameter ..... 60
Gea and sea effects Par stendiameter in E4 ..... 61
Per se perfarmance far number of capsules ..... 63Heterosis for number of capaules65
Gea and aca offects for number ofcapsules in E.266
Table No. Title of the Table Page
26 Gea and sca effects for number of capsules in E3 ..... 67
Gea and sca effacts por number of capsules (Over environments) ..... 68
Per se perfarmance Par capsula aize ..... 71
Hetarosis for capsule size ..... 72
Gica and sca effents for capsule siza in E1 ..... 73
Gica and aca effects for capsule size in E2 ..... 74
Gea and sca affects por capsule size in E. 3 ..... 76
33 Gea and aca effects Por capsule size in E4 ..... 77
34 Gea and sca effects for eapaule size (aver environments) ..... 78
35 Per se perfarmance for number of atigmatic says ..... 81
Hetarasis por number of stigmatic rays ..... 82
36Gea and sea effects for number ofatigmatic rays in E283
38 Gea and sea offacts por number of stigmatic rays in E4 ..... 84
39
Gea and sca affacts for number of stigmatic rays (ovar anvisonments) ..... 67
40 Par se porformanco Por latex yiald ..... 88
41 Heterosis Por latex yield ..... 89
42 Gea and sca effects for latax yield in El ..... 91
43 Gea and sca spfects Por latex yield in E2 ..... 9244
4546Gea and sca affects for latax yieldin E393
Gga and sca effenta for Latex yisld in E4 ..... 94
Gea and eca oppecte for latex yisid (ovar anvizanmenta) ..... 96
Per an performancs for seed yield ..... 98

## IHTHODUCTION

Pappies rank amangst the most exciting Plowers in cultivation with an exeiting range of colours such as white, pink, red, bluish purple and purple. Poppy cultivation Por opium has been in vague in Italy, Greace and Asla Minar sines entiquity. The epread of its cultivation through fisia appears to have been primarily dus to Araba . At present opium poppy is cultivated mainiy in India, Turkey, hustralia and U.5.s.i. It is also grown in smaller araas in Yogoslavia, Bulgaria, APganistan, Pakistan and Japan. Iran, which han been once a major producer of opium had prohibited ito cultivation in 1955 .

Opium poppy is rastricted to notipled compact tracto in three traditionally poppy growing 5 tates vizo, Madhya Pradash, Rajasthan and uttar Pradsah . According to annual Feports of Narcotice Departinent the aras increased Prom 39,485 hactarea in 1972 to 57,108 hactares in 1976 . From the yoar 1976 onmards, bacause of slump in demand of indian oplua in world narket, area declined under this arop and at presant it ia groun in about 35,000 hactares . This erop provided aubsiatance to sbout 250 thousand pamilias in shout 7-8 thousand villuges and Petches about flupess 600 millian in poraign axehange . The hll India average yiald of apium ( $700^{*} \mathrm{c}$ ) increased Prom $30.39 \mathrm{k} / \mathrm{ha}$. in 1974-75 ta $33 \mathrm{k} / \mathrm{ha}$. in 1979 - 30 . The highest avarage oplum yield obtained at the
oxperimental Para is about $78 \mathrm{~h} / \mathrm{ha},\left(70^{\circ} \mathrm{c}\right)$ and thia shows the existence of wida gap butween the potantial and the average yield recarded . The avarage seand production of poppy is about $500-700 \mathrm{~kg} / \mathrm{ha}$.

The State of Madhya pradssh canstituge about 50 persent of the total ares in the country, of which about 80 percent area is in Mandsaur 01strict. Tha physiologivally satured capsule when incisad yisids the whita to pinkish juice which solidipiss and is galled raw opiun. Opiun is known to possess 26 alkaloids af which morphine, Codeine, Thabaina, Papavarine and Narcotine ara important and are axtracted Por medical uns vize, analgesic, suphosla, ralaxing voluntary musclas, spinal stimulant, and generally usad as pain killer. Basids latex, seed and husk are aleo of acanamic impartance * Pappy seed is a rich suusce of pratain ( $22.3-24.4 \%$ ), minerals, vitamina and ail ( $44.50 \%$ ) . Poppy straw can be utilizad for Pibre boards and straw basds (Chawala, 1978) .

Pappy bresding has been done mostiy in Russia and aurrounding East European opuntrids . Tha asthada adopted vere generaliy thoas prevelant in thase areas ioe simpla salactions, hybridization and axploitation of hatoroass. Howavar, the information regarding tho une of latest etatiatical aating designa io notably absant. The publishad work in thase arasa ara in alavio lanquages and Journala ora nat sasily avallabla In India of

市 survey of iftaratura on opsum pappy shaws that although a gaod riaal of infornatian is available regarding growth, yiald, elimatio candition, raquiremant of soils and Pertilizers (NPK), In Eastarn iftaratura, vary iftele is reparted about the nature and accurrance of variability, inducad variability, garmplasm avisiuation, variatal evaluationg, exploitation of hetaroais and type of gena autions in available 1iterature . Gupta et $a \underline{\text { at }}$ (1978) feel that it ls most desiraplo to hava intansiva breading/selection programs ta identipy and to avolve apacific innas Por high yialds and high morphine codelna ratio.

Enviromment plays an important rale in poppy
cultivation. The Pactora like tempariture, Ral avive Humidity and eloudinesa of atmosphara during lancing opesation affecta the latex yleld of this grop . Cold windy seasan, and rainfall dusing crop period affect the erop adverael-y (wigan at al. 1980

Ta Poraulate a detailad breading programan Por avalving batter typas of opiun pappy, auitabia far variaua frowing conditions, it is assantial that the intareral abionahipa anong varinus aconomia chariactara and their neture of fnheritance ia prapariy underatood. The combining ability analyais Furniahes useful Information rogarding the suloction of suiteable paranta for offaetive hytaridization and at the Base tias to aiualdata the natura and magnituda af dipfarant
type of gene actions involvad. The diallel analysis in Inter-varietal crossas of oplum poppy will raplect the parameter wa seak to interpret fur differant genetiaal consequences and phenamana in which ue are interested, pareicularly on combining ability of parenta and Por isolation of apecific hybrid cambinatians heving gaod specific eambining ability offacta.

In the present invesklgation, eight parants ware drawn from different agroelinatic zonas of aplun grouing tracts of India. Salection of parants was based on Impurtance of dipferent economic oharactore, to gonarate the information on gene action and alac ta select desirable parents for furthar ureading programae. In the praannt invastigations, the rasults of diallol crossea of these aelactad pasento are rapartad.

## CHAPTLR 2

REVIEW UF LITERATURE

Th\&s chapter emphasizes on tha aspedts of variatal improvesents and correlation studies; heterosis in intra and intar-speasfic orosses, gene aceion and combining ability analysia and Pou referances sa polyplaids and mutation aspect of opfua poppy crap. Litaratura on gane aution in mombining ability analysia is very scanty in this erop.

## 

As asarly as in 1907, hurst , reporet that in Papaver samiferyg, culoured petale wese dorinant ovar white, purple Plasers ovor red and black baadi area of the petal aver white . Laaks and Pershad (1920) alau raported the Inharitanes of petal abiour and aged. Deguinot (1926) obiservad that the flower and aesal coat eulour $\$$ da dominant. Hiyake andImes (1927 a) studied the Plowar colour, shapa of goralla, petal serration, snoothness of stack, doubleness of flowar and stan haisynasa in ppium poppy - Prochsska (1928) reportad that opiuin poppy capsula appeara stristed due ta eapty laculas, which ia gaused by ounlas ahartians. Psarawa (1939) found that sesd colaur is inherited and is not ralatud to the ail eantent and yiald of sead is not affactad by branching and shape of capsule. Ho correlatian between shape of capsule and oil eontent of sead was raportnd by kohoutava
(1953) . Kapp and Katilla (1955) Pound in thaic braeding experiments that marphina contant ean be incraased by 30f In Rumania and it is affacted by time of sowing, percent eross polifnation, varlatias with blue sead and rain water raceived theing grouing seasons e Hlavackova (1955), Pound tnat under Czochalavakian condstion the Duteh variaty Hordster contains tha highest amount of mazphins, while Bulgazian varioty had reinabively low amount of marphino. Kopp (1957) roportad that plants aith largeg pear shapad capaula and blue seod ganerally yiold high morphine contant . 3askany 是 al (1959) raported that blue calour of neod bas doninant and capsula Porms show matornal influenca. Voskarusa (1960) observad a positiva and significant casralation between saad and acrphine enntant . horasz (1960) performed saleation in isalatard self pallinatad planta and obsarvad that morphine content of eapsule inaraasad fras $3.37 \%$ ta $6.04 \%$ on an average. hopp at al (1961) hadd the view that in salaction procedure for high marphina, plants with highest as well as lowant contants shoult be diacarded, since high amount had dageneration and a decrease of marphina will be abserved in progenies * Zaschke (1962) Pound that German vaskatias which wers bred for high all and saed production, normally contain 0.200 .45 morphina hownver whita varietien had moxphine upta D. O, - Anticeev (1963) sxamined 6 virieties fram bentral huia and USSR and aboarvad that palyploid types ara highes yialuor of latex and morphine por unit araa Ardurson and Loot (1966)
outlinad the braading ghjective of araeding trials. Thoy held that sinca poppy cultivation far morphina is unprapitablas the new ain shauld be higher aged yield and ail contant. Naienguska and Fapovska (1967), observad that yield np opium and seed have positive and height and number of nodea had no correlation. Herisaat (1967) conductad experimants with eight variatias. He Pound that aarly Plavering was Pound to be associatad with a high alkaluid lovel. Von Hotighm (1970) raported breading programan for neveral specias of Papavar - Marphine and thetbaina rich straina weza obtainad and describsd by hia . He paid attention to apratachnically important charactora as well as alkaloids . Ved kaj Nanrikaan (1970) did experiments with stasins of opium poppy during 1965-1969 . Ha scrasnod the typad saterial for high spew yislder - Ha pound that crude Pat and eruds pratain vaxisd A littio in hia axperimentsl material. A high heri talaility In plant height and a low ana in sasd weight was roportad in two variatias by Hlavackava (1972) . Khanna and Murty (1973) and Legg (1969) held viaw that production of alkalaid was bath under gunetical and ervironmental contral.

Naw pranising varieties wace evolvad by savaral aciencistu . Poppu 荲 ad (1975) did amplex braeding trisln. Hn came up with mew promiaing pappy varieties with high marphine contents of dry gapsule (aver $0.7 \%$ ) o New variaties sa duveluped mara ataila sype for binter beanans o Kionn (1980) avalvad two cultivire vizen Mop 78/3 and Mup 7B/16

In Mashya Pradash, Indiap and ceported that thase twa new variaties regurdud 9.3 and $11.8 \%$ mora 1 atex, 2.68 and $0.89 \%$ more morphine yield/ha. respactivaly than the lacal check. Both typas according to him, racorded slightly battas saad and husk yiald. Wigamy nt A1 (1979) raposted result uf 1740 Bamples of 67 villages in Mashya Pradesh agea of India and found that range of latex yield was 50 to $115 \mathrm{~kg} / \mathrm{ha}$. and that of seed was $478=1412$ h/ha. The mosphina percantage varied Prom $4.09 \%$ to $16.46 \%$. In anathar rapozt ligam at ajo(1932) described tha germplasin of Madhya Pradesh .

## 

As asarly as in 1923, Kirosi eransed asveral innas with diatinct characters of aiza and Pora of capaula, maturatia pie and reportad that hybrid vigour in hybrids was aignipicant Lavara and chiatari (1926) Pound that hybrids batwesn blua and whita sasdad varietias of pappy hava higher and better quality of mosphina and yiald . Kahoutava (1953) attampted erosean betwsen savan variatias and meparted hyarid vigour por oil contant in 60 percant ap the hybrids ha had studied. HIRvatikova (1959), initsatad erossing programate almad at getting high sosphine content of dry poppy saad and Pound that hetesoais occurrad in F p Par saed wesght and plant haight, but the morphine eantant ses intermadiate between the parants Sarkany at af. (1959) abservad In his atudias that hybride gram
 capsule and saed woight by 10.76 peraent. Kasahada and Milezulska (1962) attsmptad hyteidization of fous varietise and
found that afpact of hetarosis was most conspicuaus whan tho parant dipperad slightiy in respact of given fastusas. Kaskova (1963) raportad that hybrid vigour was notad por yield of saed, pous and ail . Sosa- Uowrdenil 暑 al e(1963) reportad that whan two varietias vizo, Marsalili (white Plawarad contain two glueasides) and Flora 111 (petal with rad base and 1 Qlucoside) wera crossed. $F_{q}$ had generally vialat calaur in the Hotal . The $F_{2}$ ahosad zegressions and intermadiate types. Mraz (1964) described the method ta pind out the proportion attributable to an improvament in the stata of hasith of a hybrid as a rasult of hetarasis. Danos (1965) reports that hybride dipfared in morphological characters and alkaloid spoctrua. Ha obasrvad hateroais in morphine content and sucondary alkalaids a He also raportud in 1966, that $\mathrm{F}_{1}$ hybrida hava graetar narphina cantent and gratar eapsule welght then the parents but the secondary alkalosda wora Intermediate. In the $F_{2}$ gonesation, lass calaured plenta had more morphine and lasa socondary alkaloids than the dark coloured planta - Popov and Dimitrav (1966) found that heterosis affacta are mare pronouncod in hybrid cumbination in whioh parents ars acologically distinct and higher yleld of crude opium, sasd and capsula was there, with resiatanca to law tomperature and bactariasia. Anderson and Laot (1966) afudied the proganies of hybrids and found that 9 erosses had high morphins contents than thaif paronts * Hiezulake (1967) reparted that if parente tars blus ageded
poppy (Hulgarian arigin) Incraased seed yield in Fi was observed. Morphine content was aither intermediate or exceaded both thin pasents. Marice and Louarn (1971), reported that despite variation caused by eliaetic Pactars, selection of ilnss Por high marphine content can be medo This charactar shows no hatarosis, $F_{1}$ being intermediate . Popou 是 al- (1971) used creases within turcicum sub-species and found that morphine content of dry copsule showad internediate heradity and $15 n$ ss with high morphina gan be 1solated. Popou 早 ale (1974) reportod hybsid vigour far morphine cuntant in dry capaule. Popov et aĺㅡ́(1975) reparted that very promising offspring and hyorids ( $F_{1}$ ) were obtainad by hybridization betwasn varietins of pappy. Popou et al-(1976) reportad hybrid vigour for number of capaula (2*3 capsula per plant). Tha total and meen capsule weipht proved highar in all hyorlda. The marphine contant was also highes .

## 

Hiaringhan (1925) erossed ㄹ. gunalfary vare nlarun with wild poppy E. Hetigegum $O C_{\text {, }}$ and found that hybrid had all the parantal charaetesa dearfaned. The planta wara knotivy, number of atamens wese much reduced, pallans abortas and number of stigmatic rayo ranged Pran $3-6$. Bras (1927) mportat that D. hungarian is tha hyboid of E. dublua $x$ E.g.gigaqun ver. Aeniprophydium and not that of E. dubium * E. chasas var. calvellum " Piravane (1927) raporting the rosult uf crose
 diveraitty of progenioe may be Infuenced by aaturity of avary
at timn of palifnation. i, asaeva (1929) wasking uith same eross found $73-93$ percent success , when E-bractgatun was uagd as male and na seed la obtained if it was used as fanala. The $F_{q}$ was not unifarin. Tha $F_{2}$ plants wers perental but thot cold rasistanf. He reported the same rusulta in 1930 alau. In tha sans crass Yasui (1937) reportad that $F_{1}$ appearod Interinediate and there was irragular chromasamal bohaviour in msinsis. Krwatami's Asahina (1959) working with crose of E.gomnlfarum and E.griantaig, pound that hybrid was pereñal, resembling the fenale parenta in stem, Plavers, bud and leaves . ALkaliads camsan to bath paranta ware present. In the same cross Tetany1 et a1. (1961) Pound that in F, ganeration tho rain alkeloid in 75 percent of the plants was morphine, in 13 porcent codeina, in 7 percent thebaine and in 3 parcent papavarine . Moxphine was aleaye prasunt but occarionsily one or the other aikaloid was absent. Lorinz and Tulanyi (1963, 1966) warking with the sana erasa reported that $F_{1}$ whowed both Interandiats and naw marphalogical type. Heterosia offoct was noticed in $F_{2}$ rather than $F_{1}$. Von H. Bohn (1965) raportad that when E.bractestum Iind (which contains larga asount of thebaine) was crossad with B-samnifarun L.a tha F, hybrids containsed the alkaloida of both parents and morphine was the main alkaloid present. The hyorids aamesd tu heve praduced large amount of thebainm. Ruakin (1972) warking with gegagniforum $(m=11) \times$ P-pllagur Sipth at 5 mith $(n=14)$, shauad that morphine; codeine, papaverine and narcotine edntent af hybrid wae ainilar ta that of E.gidq4y

Celchicine treatment of Pesomndparum was usad by woskase to obtain tetraploids (Furueate, 19a0; Volovov, 1941 and Michalski, 1959) . Hirishi (1960) concludad that P. getiqurum is ang of tha allatatraplaid of Eesannifarum Hutations induced by $X$-ray (femusei, 1959), by chamicala (Ivanova, 1972) and by Gamma radiation (Higan and Dhumale, 1982) are reportad in iiteratura. Spontanoously acourring mala atarility was reportad by Blaringhera (1932) and singh and khanna (1970) in oplum poppy .
2.5 GONBINING RDILITY ANO GEFEL ACTIUA

A very littla roview is available an fyena aetion and combining ability paramatars of opium poppy e Unly recently this aspact of gane action has besn explored and some reporta are being racuivad

Cartain aorrulation batween $y i \operatorname{lol}$ and cumponents of yivid in Eegomiffarum was roportad by Khanna and singh (1975) - Singh and Khanna (1975) atudied the dogree of hateroais and naturn of combining ability in opium poppy in 5x5 diallal erass. They raportad that hetarasis sas marised for capsule number and oplum yiald. Paor haterasis for morphina cantent was absarved. Sea and sca variancaa wara Pound to be shgnifieant; indigating addiEIVe and nan addttive gene action buth of shich ara important in apius papay.

Fredaminance of additive companent Par capsule weight indicated that thaid character can bu Improved.

Popov and DImitrove (1966) studind PiPty cross (Hybrida) combinations untween varieties of Sadav, USSAR and Hungary. Thasa hylarids ware sualuated for crude apium, saed yield and masphine percentage. Hybrid vigour for arude opium and sead was atrongiy manipested in hybrids with diatinct parants. Heterasis apfact in poppy is alsu manifentard with ragard ta graater rusistance ta law tomparatura. Thay suggastad that diatinct parental erassas shauld be attamptod Par gateing better latax yield.

Saini and Kaicker (1982) reportod combining ability analysin for oplum yield in opium poppy. Thay usad line $x$ taster analysis techniqua. Ten iines of divarse origin and Pive tastars sera used. They raportad highly aigniritant mean sum of square for pazent Vs hyorid Por opium yield, indicating a substantini amount of hybesd vigour presant in thoas erasaes Hybrida differad amang thamselves signifleantiy indieating phanatypic diveraity among themsalvas ganeratad by the Inherent varlability prasant in lines and teaters. Femalas ware more geneticaliy diverae than malsa. In combining ability analyais, it man indicated that (i) additive gene effoet was predominant, (ii) ges was of greatar magnitude than nea, Indienting thet the nakura of gane action was prefoninantiy
sdditiva and (15i) parant DCG was Pound to be generally hess combiner -

Saini and Kaicker Pels Pras thete ahemexatians that bhaic atudien shawed matily additive type of gene action in conczast ta mosely nan additiva gane aetian repartad by 5 ingh and Khanna (1975) whiteh may bet due to the parental material usad . Saind and Kaickery material had wide genotic diversity firussiar, Hungary, $\mathcal{L r a n}_{\mathrm{f}}^{\mathrm{FRom} \text { Yagosiova, }}$ Switzerland) while Singh and Khanna usad 1 inited ganetic variability created by braeders.

## CHAPTLR 3

PA TEREAL ANL METHODS

### 3.1 GEOGRAPHIGAL LOCATIUN

Mandaaur ( $24^{\prime \prime} 03^{\circ} \mathrm{N}, 75^{\circ} 08^{\circ} \mathrm{E}$ ) is situated on tha Malva plataat at an muaraye elevation of about 435.2 maters abova saa leval. Exparimantal aras was lacatad at JNKVV e Regianal Resaarch Station, Bahadari, Mandaaur, 3 kilometers away Prom Handsaur ofty on Mandsaur \$itamau road.

### 3.2 GEDLDGY

The soil was black clay laam and the rock underlying Is doccan trap camposed of basalt - Avorage dapth of maII being $3^{1}$ to 44. The sxparimantal noll was analyaed to 263. $7.2,588 \mathrm{~h} / \mathrm{ha}$ e availabla NFK raspoctivaly. Tha goil was high in grgania garbon ( $.70 \%$ ) with pH 8.2 .
3.3 CL IMATL

The olimate op Randaaur is mansaonic with pharactaristic threa seasons vize, Rainy (Juns-Septemaser), Winter (October-January) and Summer (February ta May). The average zainfald of the tract ia 960 mase mean maximum and minimum tamperasura theing $35.14^{\circ} \mathrm{a}$ and $19.54^{\circ} \mathrm{a}$ saspactivedy, During 1979-80 and 1980-a1 the total rainfali was 456 min and 662 हin. thila tha number of rainy days were 37 daym and

43 taya raspectivedy.

### 3.4 AGHICUL TURAL WAERATIUNA

Tha exparimental piald vas brought to Pine tilth by ploughing and baikharing. Sowing was dane in the second weak of fovenher (normal adoing) and late sowing was dona 30 days 1 ater. Seeds were traated with Pungicida, Dithana M-45 \& 3 y $/ \mathrm{h}_{\mathrm{g}}$ saed. Sowing was done in 11 nes 30 cm apart. hall sottan FYM was addad uniformiy of 10 to/ha* and thoroughiy mixad in soil. 100,50,30 NFW k/ha, was applied . $1 / 3 \mathrm{n}$ and Pull $F$ and $K$ was applied befars squing . Remaining N was top dresaed in two equal splits at 30 and 60 days age of tha crap. Irrigation was dane immediataly after sowing, and ropeated 7 days aftar to halp germinatian. Subaaquent Srrigation was givan to bring the sail at Piald capacity. Gara was takan that irrigation was not miasad at rassat, but, Plowering and prelancing stage af erop growth. Thinning and weading were done thrice in erop saasan, ta uaintain plant to plant diatance of 10 eif to obtain optimum plant population of 3-3.5 lakhs/ha. Tine to timn uniform spasying of fungicide and Insecticiden were danu to pratuct the crop Pron disnasna and pasta.

Capaulas wnre lanced when thay attained phyaiolagieal
eatusity. The laneing was done with the holp of a thrae bladad langer duging the hattest part of the day in tha
afternoon - Incisians were mado vartically from bottoan to top of copsula (F $5 \underline{q} \cdot 1)$ taking gare that the incision should not crass the masocarp thicknesa. The viscous 1ntex vas collected early naxt marning with the help op iran sogop (Fig.2) and the praceas wan repaated avary 72 houra till the tapaula stoppod ouzing out latax.
3.5 EXPLAIFMTAL NATERIAL
3.5.1 HKAENTS

Un the basia of divarae morphological oharacters and adaptationg oight parants were salactad For tha proasit study. The pure and aelfad aned meintained at frandsaur by Shai facomishra, Jr.icisntist, Plant iraeding uss takan Par furthar wark. Tha parents were to

| P1 (Ranzatak) | patals pink and big, non sergatud sargin Preduncie nan halry - Plants of avaraps height ( 80 en ). Capaulen anme ta lancing in 120 days . Salentian belonge to Madhy Fradash . |
| :---: | :---: |
| P2 (0cce) | Petala whito and madium size, non sarrata margin. Paduncla non hairy. Plants having Little saaller height (75 cm) . Capaules oume bu lancing in 105 days. Selactson Lelunga tu Majeathan. |
| P3 (Telsa 1) | Fetaia pink and medium siae, non merrated sargin. Pedungle nan nairy. Plants of average haight ( 00 aa ). Kapaules have |



FIG 2

|  | Eypical groen ahinfing othatactariatic glving ofllah laok. Capsules came tu laneing in 120 days - anleotion belangs to Nadhyo Pradssh . |
| :---: | :---: |
| P4 (Irrianian) | potals white and big, non sarratod nargin Poduncia hairy . Planta of mediun haight $(75-80 \mathrm{~cm})$. Capsules coind to Lancing in 125 days . Selection Prom nxotie miterial |
| P5 (LL3) | Potals pink and mediun ofze, non serrated margin. Paiduncle nun haizy. Plants little taller ( 82 cm ) . Capsuleas some tu lanoing in 135 days - Sead orlginally recalved Prom IAKI, New Daihs . |
| PG: (up unite) | Patala white and big, non serraked margin Maduncle non hairy . Plant height Bo em Capaules coma ta lancing in 115 days. Salection balamgs to Uttar Pradash. |
| p7 (Hapsmea) | Patalo pink and madium size, non serratod margin. Poduncle non hairy. Plants littlo taller ( $B 4 \mathrm{am}$ ) . Copaulns auan to laneing in 120 daya. Sued oesginally roculved Prom 1hMI New buind . |
| P目 (Galania) | Patals red and big, assrated margin . Plant helight narmal ( 80 ea ) . Capmules come to lancing in 120 days . Selectian belongs to Rajosthan. |

3.5.2 HYBABDS

During gabl apason of 1976-79, salfed pure sead of a ganotypas wase groun in an isolatad blat and F , hybeids in ali posabble combination mxeluding racipeuasia worn
proparad i.s. $P(P-1) / 2=28$. Thase hybrida ars idantipisd in text as $1 \times 2=$ Ranzatak $\times$ DCG, $1 \times 3=$ Ranzatak $\times$ Telia 1 and so on . Sufficiant seads of F, hybzids wara made during that year and half of tha soed was utilized for 1979-80 and next halp was utilized in 1980-31 trials.

### 3.5.3 LWVAHONAL.UTS

Four seperate enviranmenta ware Parmed thy dete of souing and yasr of planting . Since contrast enviranmants were tque preparad Por accurate avaluation of experimonta, data of sawing separatad by une month, created the ountrast anvironments. The four enviranments were :-

E1 (Enviranment ona) Kormal sowing during 1979-80(12-11-197日)
E2 (Enviranmant two) Lates sowing during 1979-ad i.a. ana manth lata Pran E1 dato (12-12-1979).

E3 (Enviranmant thras) Narmal aowing during 1980-81(15-11-1980)
E4 (Environmant Pour) Late sowing durint 1980-81(15-12-1980).
3.5.4 LAYGUT AWD DESILEM
3.5.4.1 TRLATHEVTS

Eight paranto and twanty night hybrida (In all 36
entrias) wera tasted -
3.5 .4 .2 DL .33 KN

Handamiaed block deaign was used.
3.5.4.3 PLOT 512E

Singls row of 1.5 matar langth, 30 cm apart for aach antrisa tass Eakan ( $1.5 \times 0.3 \mathrm{~m}^{2}$ ).
3.5.4.4 REPLICNTIUNS

Thres saplications for anch snviranment . Twa puard rume wexa kapt on anch sida of raplication.

### 3.6 SAMPLING

Five randamly selectad plants par plat unra tagged and folluwing absarvatinna wera racarded on these plants. Hean of thase Pive sandonly selectad plants wers sarked mut and reparted as mean par plot .

### 3.7 LUSELRVATIDHS HECLADED

absarvation were recorded on the Pallawing
eharactars -

### 3.7.1 HEIGHT OF PLANT

Height of plant was recorded in cing from the pirat Laaf node to apex of terminal bud on the mein atan.

## 3.7 .2 LLAF AREA

Deaarvations wara racorded on the finth lanf Prou battom (dacision of oraup mesting of oplum ruanargh workers at Lucknaw 1978) . Naximui Inngth of Laaf and maximun Laaf aldth in cra were zagortlod * Leaf aras was ealculatad by multiplying Lxi of leaf ( $\operatorname{ca}^{2}$ ).

## 3.7 .3 STEH GLAME TEM

Stan diamnter was racardsd by varniar callipars. Diametar of stam was recorded noar about geh laaf. 3.7.4 MUHULTR OF CA 5 SULELS/PLAHT

Total numbar of capsulas aera racorded on plants. Only those capsulas which had contributatad to yield paramster were eauntod.
3.7.5 CAPSULLE SIAE

Langth and braadth of capsula on main branch wera recordad in em and converted to copsula siza by matiplying Lx日 ( $\mathrm{en}^{2}$ ) 。
3.7.6 HUHEER OF BTIGRATIC RAYS

Humber of atigmatia raya an espsula an main aranch
tun rucgaded.
3.7 .7 GHIUM YILLD HER PLANT

Opiun yiald par plant tans racordad in gon and
convartad tu $70^{\circ}$ consistancy -
3.7 .8 SLLLO YIELD PLR PLAHT

Sesd yisid per plant was recosded in gai.
3.7.9 HUSK YIELD PER PLNAT

Nusk is the left out of capsuls after sand has tanen
takan out. Its yisid per plant nan recorimd in gm . 3.7.10 mumber UF EFFLCTIVE LANCING PER GAPSLLEL

Effactive lancing is dafinad an dancing which haa given latax yisid. This can ba aaslly varifiad by ingneeting the Lanued capsula and Pinding whather that lancing has given

1atex ur not. Mgan number of affactive laneing per capoula was racorded.
3.7.11 MLRPHIHE PERCENTRGE

Sines opium collectad from each plant or by 5 plants per plot was very swall in quantity, and as thare exsisted no Panilitios at Rosearch Station ta earry out sorphine analyais, samplas for marphine analyisia were sunt to Uplum and Alkalaid Korks, Namauch . The Pactory requings 15 gias miniaum sampla to run the marphing tant . Tharafore, oomposit samples of full row of traatinant over replicatians ware made, tha latex was theroughly maxad and sampla drawn and sant for analysis.
3.8 STATISTICAL AHALYSIS
3.B.1 TESTING THE SIGHIFIGANCE UF GLNOTYHIC DIFFEREWCES IN EACH ERVIROTAFETT

The dats for each character were analymad in a convantianal way as ragomanaded far randomiand block dasign (Panse and 5ukhatine 1957) . The aum of squares Por 36 genotypes wars partitioned Inta thras domponenta vizo.
 Appropriato ANQUA is given below:

## ANOVA FOH HBI AHALYSIS IN LACH ENVIANHAEHT゙S

Sausab of variation df

## Raplications

## Ganotypa

(a) Pazenta
(b) Hybrids
(c) ( P Va H )

Espor

Total
df

$$
\begin{array}{ll}
(r-1) & =2 \\
(g-1) & =35 \\
(p-1) & =7 \\
(h-1) & =27 \\
& =1
\end{array}
$$

$$
(r-1)(g-1) \quad=70
$$

$$
=102
$$

## 3.B. 2 TCSTLNG THE AIGALTICANLE GF GL, WOTYPIC. DIFFLRENCLS (QVER EHULRORALHTS)

3.8.2.1 REPLICATEG DATA

Whan analysis was significant in esch of the anvironments, pooled analyais was done Pollawing panaa and Sukhatme (1954) - Far poalad analysis bnly thase anviranmantes wera cansidesad Par a charactar in which mean squasen eara aignificant An opprapriate AMUVA is presented belre i

| Suurce of variation |  | df | E.mA | $E=2$ |
| :---: | :---: | :---: | :---: | :---: |
| Equisammanta |  | ( $\quad 0-1$ ) | 3 | 1 |
| Replicatlon quar E. |  | pooled | ¢ | 4 |
| Ganotypas |  | ( $9-1$ ) | 35 | 35 |
| (a) parents |  | ( $p=1$ ) | 7 | 7 |
| (b) Hybride |  | ( $h=1$ ) | 27 | 27 |
| (c) ( P NS H ) |  |  | 1 | 1 |
| Genotypen $\times$ E. | (g-1) | $(3-1)$ | 105 | 35 |
| (a) PXE | $(\mathrm{p}-1)$ | $(3-1)$ | 21 | 7 |
| (b) HxE | ( $h-1$ ) | $(0-1)$ | 81 | 27 |
| (c) $(\mathrm{P} / \mathrm{VaH}) \times E$ |  | (e-1) | 3 | 1 |
| Erros |  | pooled | 280 | 140 |
| Takal |  |  | 431 | 215 |

3.8 .2 .2 NON REPLICATED DATA (MORPHINE, $)$

Taking anvironmants as lacations 36 ganotypas wara analysised in RUD . Approprsate Pormat Paz NKGVA is presentad below :

## ANUVF (MUNPHIVE ANALYSIS)

Source of variation
Lnvisonssants
Genotypa
(a) Parant
(b) Hybridd
(c) $p$ Va H)

Errar
Tatal
df

$$
(a-1)=3 .
$$

$$
(n-1) \quad=35
$$

$$
(p-1)=7
$$

$$
(n-1) \quad-27
$$

- 1

$$
(a-1)(\pi-1) \quad=105
$$

$$
143
$$

3.月.3 LOMBIUING ASILITY ANALYSIS

Griffing's model 1 method II was followerd. 3.B.3.1 GOPGELNING AEILITY ANALYSIS IN E.AGH ENVIMOHMENT

Mean valuas of aach charactor over raplicatians were tasid for anslysis as suggested by Eriffing (1956). 3.8.3.1.1 EATIMATION DF SUM OF SLUARLS
$S S_{g}=1 /(p+2)\left[\sum_{i}\left(x_{10}-x_{j i 1}\right)^{2}=4 / p x \ldots e^{2}\right]$
$\left.5 S_{s}=5 \sum_{i, j^{2}}-1 / p+2\right) \sum_{c}\left[\left(x_{10} * x_{i S}\right)^{2}\right]+\{2 /(p+1)(p+2)\} x_{0}{ }^{2}$
$M^{1}$. Mean squaras obtaines in RBD is further dividad by 3 (number of ropileations).
3.B.3.1.2 AKUVA FOR CURHINLHG ABILITY (LBAFFING 1956 MOUEL I ME THOLI II)

3. 0.3 .1 .3 ESTIPATIUN OF GLA ERFLCTS

The genaral combining ability effacta is astimatad
as Pollows:

$$
\begin{aligned}
& \hat{g}_{1}=1 /(p+2)\left[\sum_{i}\left(x_{10}+x_{i i}\right)^{2}=(2 / \mu) x_{2}\right] \\
& \text { Accordingiy, } g_{9} * g_{2}, * g_{8} \text { offeeta wore calaulated }
\end{aligned}
$$

### 3.6.3.1.4 हSTIMATIOR UF SCÂ EFFECTS

The apacific combining ability offacts wera calculated by using follawing pormula :
$s_{i j} \hat{1}=x_{i j}-1 /(p+2)\left[x_{i *}+x_{i 1} * x_{0 j}+x_{i i}\right]+[2 /(p+1)(p+2)] x_{0}$ Accordingly, $S_{12}{ }^{\circ} 5_{13} \cdots{ }_{78}$ (in all 28 affacta) wara calculatad .
3.8.3.1.5 STANDERELD ERMDRS

In ordez to evaluate the accuracts of combining ability astimatos, standarad errar for dipforant sompariaions wers calculated as under :
$\mathrm{SE}_{(\hat{\rho 1})}=\left[\{(\mathrm{P}-1) / p(\mathrm{p}+2)\} \times \sigma^{2}\right]^{\frac{1}{2}}$
SE $(\hat{g i}-\hat{g} \hat{i})=\left[\{2 /(\rho+2)\} \times \sigma^{2} \quad\right]^{\frac{1}{2}}$
SE. $\left(\text { Sîj) }=\left[\left\{\left(p^{2}+p+2\right) /(p+1)(p+2)\right\} \times \theta^{2}\right]\right]^{\frac{1}{2}}$
5E. $(5 \hat{1}$ J-5Sk $)=\left[\{2(p+1) /(p+2)\} \times \theta^{2}\right]^{\frac{1}{2}}$
$\mathrm{SE}_{(\mathrm{Sij}-5 \hat{1 k})}=\left[\left\{2 \rho /(\mathrm{P}+2) \hat{j}^{2} \times \hat{\sigma}^{2}\right]^{\frac{1}{2}}\right.$
Using appropriate standerad areor the aigniflicance of combining ability offacts wars tanted.
3.8.3.2 COMALNLHG AEILITY ANALYSIS (OVEH ENUIROMALIIS)

Maen valuas for aach oharactar were obtalnad for genatypas over anvisonments, which were uaed Por pooled combining ability analysis (Daljit Singh 1973).

### 3.0.3.2.1 ESTIMATIUN LFF SUA OF इMUARES

$$
\begin{aligned}
& S_{5}=\sum\left(x_{i \ldots} \ldots x_{i 1}\right)^{2} /(p+2) E-4 / p(p+2) E \quad x \in *^{2} \\
& S S_{s}=\sum_{i \in j} \sum_{i j}{ }^{2} / E-\sum_{k}^{2}\left(x_{i} \ldots+x_{i i .}\right)^{2} /(p+2) E \\
& +2 /(p+1)(p+2) E \quad x_{0} \ldots{ }^{2} \\
& S S_{g \times 0}=\sum_{k i} \sum_{i}\left(x_{i, k}+x_{i, k}\right)^{2}-4 \sum x_{1, . a k / p}^{2}(p+2) \\
& -\left(x_{i \ldots}+x_{i 1}\right)^{2} /(p+2)_{\theta}+4 X_{0.0 / P(p+2) E}^{2} \\
& S S_{s \times \theta}=\quad \sum_{k} \sum_{i} \sum_{j} x_{i j k}^{2}-\sum_{k i}\left(x_{i, k}+x_{i 1 k}\right)^{2} /(p+2) \\
& +2 \sum_{k} x^{2} \cdot 0 k /(p+1)(p+2)-\sum_{i j} x_{i j}^{2} / E \\
& +\left(x_{1 \ldots}+x_{i i}\right)^{2} /(p+2) E-(2 /(p+1)(p+2) E) x_{*} \stackrel{2}{*}
\end{aligned}
$$

$M^{0}$. Moan squares obtained in RBD (pooled) is Purther divided by 4 or 2 (numbar of anvironmanta).
3.8.3.2.2 ANBVA FOR POULLD ABALYSIS

3.8.3.2.3 ESTIMATIUK OF GCA EFFLCT (UVER EWVARUMALATS)
As in 3.8.3.1.3
3.8.3.2.4 ESTIMATIUN UF SCA EFFECT (OUER ERUIRONHEHT) As $\operatorname{In} 3.8 .3 .1 .4$
3.8.3.2.5 STANDER II LRRMRS

Standar d arzor for comblning ability effecta were astimated Pollawing Daljit singh (1973).
$\operatorname{SE}(\hat{g i})=\left[\{(P+1) / P(P+2) E\} \times \sigma^{2}\right]^{\frac{1}{2}}$
$\operatorname{SE}_{(\hat{g i}-\underline{g} j)}=\left[\{2 /(\rho+2) E\} \times \sigma^{2}\right]^{\frac{1}{2}} \quad \& \neq \mathrm{J}$
$S_{(\hat{S i} j)}=\left[\left\{\left(p^{2}+p+2\right) /(p+1)(P+2) E\right\} \times 0^{2}\right]^{\frac{1}{2}} 1 \beta j$
$\left.5 E \wedge \wedge \quad[\{(P+1) / B+2) E\} \times 6^{2}\right]^{\frac{1}{2}}$ i $A \mathrm{k}$ j台k。
$\operatorname{SE}_{(S i j-5 \hat{1 k})}=\left[\{2 P /(P+2) E\} \quad \sigma^{2} \quad\right]^{\frac{1}{2}} \quad \begin{aligned} & i \neq j_{v} k_{p} \text { a; } \\ & j \neq k_{p} \text { mi: } \\ & k \nLeftarrow \text { m. }\end{aligned}$
Using apprapriate standerfd error the significance ap combining ability effacts wara teated.
3.B.4 GALCULATIUR OF HLTERUSIS

The expressian af hybrid vigour in diffarent hybrids Por sach gharastar, unge calculatad by obtaining the difference batuean means of hyeride and meana of bottar parent and betwaen muann of hybrid and maans of midparantal values . These werie testad for algnipieance by ahtaining tha standerid nreors as Pollows :

$$
\begin{aligned}
& S E_{H(B P)}=\left(2 M^{\prime} e / E\right)^{1 / 2} \\
& S E_{H(M P)}=\left(3 M^{\prime} e / 2 E\right)^{1 / 2}
\end{aligned}
$$

The hybrid vigour was expressed as percentage in text.
3.9 NONSTANDARD ABBREVIATION USED IN PRESENT THESIS
p1 1st parent in Ranzatak.
P2 Second parent i.e. DCG.
P3 Third parent 1.e. Telia 1.
P4 Fourth parent i,e. Irrianian.
P5 Fifth parent 1.e. LL3.
P6 Sixth parent i.e. UP White.
P7 Seventh parent i.e. Hafemea.
P8 Eighth parent i.e. Galania
$1 \times 2$ Cross Ranzatak $x$ DCG, and so on.
E1 Enviroment one (normal sowing 1979-80).
E2 Environment two (late sowing 1979-80).
E3 Environment three (nomal sowing 1980_81).
E4 Environment four (2ate sowing 1980-81).
3.10 ASSUMPTION OF DIALLEL ANALYSIS

The theory of diallal cross analysis is based on the Following assumptions :-

1. Homozygosity of the parents.
2. Diploid segregation.
3. No maternal effects.
4. No multiple allelism.
5. Independent diatribution of non-allelic gene.
6. Linkage is wosent.

## CHAPTER 4

## EXPERIHENTAL FINDIWGS

In tha prasant investigation aleven charactars of opiun pappy hava baen studiad. Ten charactara hava bean analysad far combining sbility follawing firiffing (1956) - Since replication wise data twera not available for morphina percentage, cambining ability analysis wa not undertaken . Hewaver, treating anviranaents an replication, data was gubjacted ta RaD analysia .

### 4.1 ANUVA RED

Significant differances wara Pound to exalat anung thirtysix genotypes rox all the charactars in ali the environmants except por stan diamater, number of eapsulas per plant and number of stigmatie rays per capsule, whare significant differancas waro only obsarvad in E4, E2, E3 and E2, E4, respactivaly (Table 1) : In paoled analysia, genotypss were faund ta hava aignificane differences for all the aharaetars excapt Pur uten diankter, whore paolad analysis was not parfarmed (Table 2).

Paan squares far parants masa ohsurvad ta ba significant Por all sharacters in all the enviranaents except Por stem dianeter in $\mathrm{E} .1, \mathrm{c}, 3$ and E.4, number or capsules pes plant in E1 and E.4, numbar of stiginatic

AMOVA FOR VARIUUS CHARACTLRS IWALYSIS) ; (WEAN SQUARES)

| Charactera | Helght of plant(em diameter (em) |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { Source of dp } \\ & \text { variation } \end{aligned}$ | E1 E2 | E2 | E3 | E.4 |
| Foplications 2 | 37.69 4.90** | 0.0154 | 0.0031 | 0.0304 |
| Genotypes 35 | $77.54{ }^{\circ *} 109.76^{\circ *}$ | 0.0087 | 0.0102 | $0.0117^{* *}$ |
| Parants | $76.24^{* *} 99.76{ }^{\circ 0}$ | 0.0041 | 0.0043 | $0.0077^{*}$ |
| Hybrida 27 | $73.25{ }^{\text {ee }} 50.61{ }^{\circ 0 \mathrm{e}}$ | 0.0085 | 0.0101 | $0.0111 * *$ |
| P Vsht | $262.52{ }^{\text {af }} 1776.68^{\circ \%}$ | $0.3474^{*}$ | 0.0429** | $0.0582^{\circ} 0$ |
| Erruer 70 | $23.27 \quad 3.40$ | 0.0073 | 0.0116 | D. 0003 |
| Total $10 \%$ |  |  |  |  |

Table Continue

| Nunber E1 | af capsuliber of stipmatic rays/eapsule |  |  |
| :---: | :---: | :---: | :---: |
| .0768** |  | 0.4619 | $0.0184^{* *}$ |
| 3.07680 | 0.7512** 1.406゙2 | 0.4952 | D.8044** |
| 0.3543 | $0.298100{ }^{\text {0. }} 1.2073$ | 0.3521 | 0.6569** |
| 0.7622 | $0.8938^{* *} 1.3000^{\circ}$ | 0.5259 | 0.8699** |
| 0.8100 | D.0726** 5.6674 | 0.6689 | $0.0661^{\circ}$ |
| 0.4135 | 0.0058 i 0.0178 | 0.6299 | 0.0103 |

Table Continus


* Signifigent at $9 x$

Table 2


| Source op variation |  | $\frac{d P}{E=2}$ | Haight of plant(can) $E=4$ |  | $\begin{aligned} & \text { Number } \\ & \text { of } \\ & \text { gapsule/ } \\ & \text { plant } \\ & E=2 \end{aligned}$ | $\begin{gathered} \text { Capaulu } \\ \text { siza } \\ \left(\mathrm{em}^{2}\right) \\ \mathrm{E}=4 \end{gathered}$ | Number of ntigmat says/ capsule Em2 | $\begin{gathered} \text { Opium yield/ } \\ \text { plant }(\mathrm{gm}) \end{gathered}$ $E=4$ | Sead yial plant (gn) $E=4$ | $\begin{gathered} \text { d/ Musk } y i=1 d / \\ \text { plant }(\ln ) \\ E=4 \end{gathered}$ | Number of effective lancing/ capsule $E=4$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Envizonments | s 3 | 1 | 22012.68** | 248701.56** | 0.548150 | $291.50{ }^{\text {e* }}$ | 4.36** | 0.420233** | 749.5951 ea | 301.2000** | 499.82** |
| Replication over E ${ }^{15}$ | B | 4 | 43.79** | 19.93 | $0.2714^{\text {a }}$ | 1.6125** | 0.06 | $0.708075 \%$ | 1.4075 | 0.9747 | 0.0662 |
| Genatypea | 35 | 35 | 101.01** | 2642.35** | 0.4121** | $6.9666^{\circ *}$ | 1.394** | 0.045291** | 11.6539** | $9.4603 *$ | 3.8205** |
| (a)Parents | 7 | 7 | 32.4000 | 1987.52** | $0.2033^{\circ 0}$ | 5.8357** | 1.569** | D.010185** | $2.3930{ }^{\circ}$ | 3.8582** | $0.1690{ }^{\circ}$ |
| (b) Hybrids | 27 | 27 | 37.69** | 2845.02** | $0.4524^{\circ 0}$ | 5.15010* | 1.271** | 0.0443650 | 14.2516** | 11.0416** | 3.773000 |
| (c) $\mathrm{PVOH}^{\text {H }}$ | 1 | 1 | 2290.00** | $2384.04^{\circ}$ | $0.7848{ }^{\circ}$ | $63.7200^{* *}$ | $3.500^{6 \%}$ | $0.315500 * *$ | 13.342106 | $6.6800^{* *}$ | $23.6650^{* *}$ |
| Ganatypa x E | E105 | 35 | 33.97* | 3065.41** | $0.5498^{\circ *}$ | 5.8141** | 0.817** | $0.004433 * *$ | $6.9920 *$ | $3.6268^{* *}$ | 2.547600 |
| (a)Parant xE | 21 | 7 | 54.9164 | 2134.95** | $0.1578^{\circ 0}$ | $4.21814^{\text {ee }}$ | $0.296 \%$ | $0.003528^{* *}$ | 2.3993** | 1.78790 | 3.33100 |
| (b)Hybrid uE. | 81 |  | 49.56** | 3210.65** | $0.0581 *$ | $5.7285^{\text {e4 }}$ | $0.397^{\circ}$ | 0.004532** | $7.6584^{\circ}$ | 4.0470 ${ }^{\circ}$ | $2.6669^{\circ}$ |
| (c)p UBH HE | 5 | 1 | 166.46** | 5657.02001 | $16.6127^{\circ}$ | 18.9566** | $2.230{ }^{* *}$ | D.008100** | $21.1482^{\circ 6}$ | $5.1870^{* *}$ | $9.3060 *$ |
| Erios | 220 | 140 | 11.44 | 137.77 | 0.0449 | 0.7172 | 0.0141 | 10.000074 | 0.9156 | 0.3395 | 0.8209 |
| Total | 431 | 215 |  |  |  |  |  |  |  |  |  |

[^0]says per eapsule in E 1 and E 3 and for saad yfald in E. 2 (Table 1) . In poolad analysis, parantal lines had highly signipicant mean squares for all the charactars (Table 2).

Hybrids diffared significantiy in asch anviranments Por all characters oxcept in E1, E2 and E3 Por stan diametar. E. 1 and E4 Pos number of capsulos per plant and E1 and E3 far number of stigmatic rays per capsula. Significant diffarances were also obsorvad in all the eharactera in poolad analysis for diffarent hybrids (Tabla 1,2).

The intaraction ( $\rho$ Vs $H$ ), was alad found to be signipicant Par all characters in all the snvironaenta mxeapt for stam diametar in E.1. numbar of capauie per plant in E1 and E.4, Par number of stigmatic rays per capaula in ET and E3 and for capsula size, send yiald and husk yiald in E4. Highly significant maan squaras were observad Por all characters por this componant in paoled analyais. The highly significant values for ( H Vs H) component in all charactars indicated the prosence of heterosia for thase charactars in prasant atudias. The interaction (ExE) and its domponants Vizer PaE. HxE. and (P Vs H)xE wera Pound to be highly significant fos all the eharacters (Tabln 1,2).

SLgnificant diffarancea wara observed Par ganotypes, parents and hybrids for morphina peraenkage. Haeavar,
(P va H) component was found to be nonsignificant (Table 3).
4.2 AVONA COMBINING ABILITY ANALYSIS

The component of variation due to gea was found to be significant for all the characters in all the environments (Table 4), and in pooled analysis (Table 5).

Mean squares for sca were olbserved to be significant in all the enviroments for all the characters except for capsule size in E3. All the attributes had significant mean squares for sca in pooled analysis
4.3 PLaHT hilight
4.3.1 Per se PERFORMANCE

Per se performance in pooled data for parental lines and hyprias is presented in Fable 6. P7 had highest

Table 3
anova for horphine plrcentace (nean of a enviranichts )

| Source of variation | dP | 5.5. | M.5.). | Cal.F.Value |
| :---: | :---: | :---: | :---: | :---: |
| Environments | 3 | 130.39 | 43.460 | $42.36{ }^{\circ 0}$ |
| Genotypes | 35 | 69.23 | 1.978 | $1.93{ }^{\text {ex }}$ |
| (a)Parents | 7 | 20.67 | 2.953 | $2.88{ }^{* *}$ |
| (b)Hybrids | 27 | 48.54 | 1.798 | 1.750* |
| (c) P Vs H | 1 | 0.02 | 0.02 | 0.019 |
| Error | 105 | 107.74 | 1.026 |  |
| Tatal | 143 | 307.36 |  |  |

** Significent at 1/f level

Tabla 4



Table Continue

a Signifisant at 5\% levol

* 5signipicant af is Invel


| Charactara | d | de | Height of plant(em) | Laap graa ( $\mathrm{cm}^{2}$ ) | Tunber of capaule/ plant | $\begin{aligned} & \mathrm{Capsula} \\ & \mathrm{siza}\left(\mathrm{cn}^{2}\right) \end{aligned}$ | Numbar of stimmatic rays/capsule | Upium yiald per plant (9m) | Soed yield/ plant(gm) | Husk yseld/ plant(9m) | Number of affective laneing/ capsule |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Sources of variations |  | 4 $\mathrm{E}=2$ | [-4 | $E=4$ | $E=2$ | $E=4$ | I $=2$ | E. $=4$ | $\zeta=4$ | $E=4$ | $E=4$ |
| Enviramante | * 3 | 12 | $22012^{\circ 0}$ | 268704.550\% | $0.5481 *$ | 291.50"\# | $4.360=$ | D.420233** 7 | 749.5959** | $301.20{ }^{\circ 0}$ | 499.82** |
| gen | 7 | 7 4 | 40.37 ** | 49583.60** | $0.1016^{* *}$ | 1.146最* | $0.2444^{\circ 0}$ | 0.052519a* | $1.2630^{\circ 0}$ | $1.2810^{\circ}$ | 0.1159 .0 |
| sce | 28 | 2 B | 9.59\% | 215.50** | $0.0601{ }^{\circ}$ | 0.4546** | $0.21390 *$ | 0.00007600 | 3.88586** | 0.6432** | 0.3496** |
| $\operatorname{sen} \times \mathrm{E}$ | 21 | 72 | 22.14** | 992.98** | $0.6604^{* *}$ | 2.765800 | $0.5773^{\circ}$ | 0.039971** | 13.9531** | $2.91050^{\circ 0}$ | $1.00584{ }^{\circ}$ |
| sea $x$ E | 342 | 282 | 25.43** | $633.44^{\circ 0}$ | $0.0470^{\circ *}$ | $2.0430^{\circ 6}$ | 0.4E29** | 0.01937900 | 3.956100 | $1.52754^{\circ *}$ | 0.8035760 |
| Esroz 2 | 2801 | 140 | 2.66 | 34.19 | 0.0225 | 0.1793 | 0.0071 | 0.000019 | 8.2269 | 0.085 | 0.0050 |

[^1]( 81.69 cm ) height as compared to 76.32 cm , the lowest for $P 2$. Cross $3 \times 7$ recorded highest height of 88.64 as against lowest in $4 \times 8$ ( 81.94 cm ).
4.3.2 HETEROSIS

A11 crosses except $3 \times 5,4 \times 5,4 \times 7,4 \times 8$ and $5 \times 7$ racorded significant positive heterosis over better parent. Highest and lowest significant positive heterosis were recorded by $2 \times 4$ and $1 \times 3$ respectively (Table 7).

## 4.3 .3 GCA EFFECTS

Only P7 had significantly large and positive gea effect in El (Table 8 ). In $\mathrm{E}_{2}$, except P 3 and P 5 all parents had significant gea effects (2wo having negativa effects). P2 Was found to be significantly superior to P4 for negative

Table 6
Pur ga perfurmance sf parants and hyorids in axf diallal of opium poppy for plant height(in cm) (Pcoled maena)

| Parant | (Ranzatak) | $(\mathrm{PCL})$ | $\begin{gathered} \text { p3 } \\ (T \mathrm{Blia}-1) \end{gathered}$ | (Irrianian) | $\begin{aligned} & \text { P5 } \\ & (L L 3) \end{aligned}$ | (up Phite) | $\begin{aligned} & p ? \\ & \text { (Hafemsa) } \end{aligned}$ | $\stackrel{P B}{\text { (Galania) }}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | 70.5a | 83.74 | 81.97 | 84.31 | 日3.30 | 96.01 | 85.65 | 83.69 |
| 92 |  | 76.32 | 83.95 | 86.49 | 34.30 | B4. 08 | 88.52 | 83.76 |
| P3 |  |  | 78.96 | 82.65 | 83.10 | 64.43 | 86.64 | 86.11 |
| P4 |  |  |  | 72.64 | 81.99 | 86.45 | 83.05 | 81.94 |
| ps |  |  |  |  | 80.41 | 85.60 | 133.94 | 63.96 |
| P6 |  |  |  |  |  | 78.85 | 05.07 | 83.47 |
| P7 |  |  |  |  |  |  | 81.60 | 86.08 |
| 限 |  |  |  |  |  |  |  | 80.10 |

Note $:$ Diagonal antries for paranta and uff dlaganal untries Por hybrids

Table 7
Heteraele Par plant meight in paoled date
Croasea $\quad$ Hever buttar parant Dver mid perant value

| 1x2 | $6.57^{\circ 0}$ | $7.98{ }^{\circ \prime}$ $4.06{ }^{\text {a }}$ |
| :---: | :---: | :---: |
| $1 \times 3$ | 3.81 e* | 12.17 ${ }^{\text {a }}$ |
| $1 \times 4$ | 9.92 ** | 6.04 en |
| $7 \times 5$ | 4.83 ${ }^{\text {a }}$ | $10.28{ }^{\text {ed }}$ |
| $1 \times 6$ | 10.10.* | 6.94 a* |
| $1 \times 7$ | $4.48^{\text {a }}$ | 5.4180 |
| 188 | 4.48 | 8.13 ${ }_{\text {en }}$ |
| $2 \times 3$ | 13.33 ** | 16.13 e |
| $2 \times 4$ | 13.33 . 4 | 7.56.* |
| 2×5 | 4.64e\% | 8.37** |
| $2 \times 6$ | 6.63 ${ }^{\text {en }}$ | 12.11** |
| 2×7 | 8. $4 \mathrm{~B}_{\text {a }}$ a | 7.10 ee |
| $2 \times 8$ | 4.57 ** | 9.04.0. |
| $3 \times 4$ | 4.67 | 4.29 |
| $3 \times 5$ | $3.350 *$ | 7.00 ${ }^{\text {\% }}$ |
| $3 \times 6$ | $6.93=0$ | 10.41** |
| $3 \times 7$ | 9.63 e* | 0.57 |
| $3 \times 8$ | 7.50 | 3.75. |
| $4 \times 5$ | 1.96 e* | 10.48. |
| $4 \times 6$ | 9.64 | 4.30. |
| $4 \times 7$ | 1.78 | 3.89 . |
| $4 \times 7$ | 2.30-* | 7.50. |
| 4x8 | 6.45 | 3.620* |
| $5 \times 6$ | 2.87an | 4.62 es |
| $5 \times 7$ | 4.41 \% | 6.04 . |
| $5 \times 8$ | 4.25 | 5.03 em |
| $6 \times 7$ | $4.20{ }_{n}$ | 6.47 |
| $6 \times 8$ | 5.49 |  |

* Significant at 5\% Leval
* Significant at 1\% laval

Tabla B
gea effects (diagonal) and sca effacts ( apf diagonal), Por plant helght in $8 \times 8$ diallal of opium poppy in E1


- Signifieant at $5 \%$ level ; Signipicant at $1 \%$ lavel
$S E(\hat{1} 1) \pm 0.82$
$S E_{(\hat{g i}-\hat{g} j)} \geqslant 1.245$
$S_{(S i \hat{j})} \pm 2.53$
$S E(s \hat{i} j-5 \hat{i} k) \geq 3.74$
$\left.S_{(S \hat{i} j-5 \hat{k I})}\right)=3.52$
gea effact. Though P1 and p日 did nat dipfaz aignlpicantly Poz pusitive gea effacts, thess were Pound to be inferiar to P7 and PG. Hawaver, P3 and PS had mansignificant jea affact Por this character (Table Y). In E3, nagative gea apfect was only recorded by PB and positive efPegt by P2 (Table 10). In [4, highly nagative gea effocts wara obaerved por P1, P2 and PA and that of pasitiva effact by P6 . Na signipicant differancas axaistad betwan P1, P2 and P4 (Tabla 11). In poolad analysis only P7 recordad positive gca affacta f (Tabla 12).
4.3.4 56A EFFECTS

In $\mathrm{E} 1_{3}$ anly tua srosaas $41 z_{0} 9 \times 3$ and $4 x$ had nagative sga eppuats, where as, $2 \times 7,2 \times 3,4 \times 6$ and $6 \times 8$ had significant positiva effects (Table 8) . In E2, highest and sipnificant nogative aca affoct maa olrasvad far $1 \times 2$ but it did not dippor signdfigantiy fram 1x8. Mina hybrida racordad aignificant positiva affacta (Tab2e 9). In ES, no croas racasded aignificant nagativa opfecta but only $3 \times 6$ and $7 \times 8$ had aignificant pasitivo sea epfocta (Tabla 10). In E4, in sil sightaen arasasa Fucardad mignificant sca affect (Tabia 11) . Five aroasea vize* 1×5, $2 \times 6,2 \times 8,4 \times 7$ and $6 \times 8$ had mignipicant sca nppaets and these exsisted no significant differance among them.

Table 9
Gen effects (diagonal) and sca effocta (off diagonal), for plant height in $8 \times 8$ diallel of opium pappy in E2

| Parent | 日1 (Ranzatak) | $\begin{gathered} \text { P2 } \\ (\text { DCG }) \end{gathered}$ | $\begin{gathered} \text { P3 } \\ \text { (Talia 1) } \end{gathered}$ | $\begin{gathered} \text { P4 } \\ \text { (Irrianian) } \end{gathered}$ | $\begin{gathered} \text { P5 } \\ (\mathrm{LL} 3) \end{gathered}$ | $\begin{gathered} \text { P6 } \\ \text { (up whits) } \end{gathered}$ | $\begin{gathered} \text { P7 } \\ \text { (Hap日mea) } \end{gathered}$ | $\begin{gathered} \text { PB } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | 1.18** | -19.180\% | -14.89"\% | -12.64** | -12.54** | -17.94\%* | -14.70** | -16.99** |
| P2 |  | - $2.88{ }^{\circ}$ | $11.17{ }^{\circ}$ | 8.420* | 0.22 | 6.12 ** | 0.36 | - 0.23 |
| P3 |  |  | 0.13 | - 0.99 | 3.51 "* | - 1.11 | $7.350 \%$ | $4.76{ }^{* *}$ |
| P4 |  |  |  | - $1.722^{\text {es }}$ | $=3.64^{\circ 0}$ | - $3.96{ }^{\circ 0 \mathrm{~L}}$ | - 1.50 | - 4.09** |
| PS |  |  |  |  | 0.48 | $3.46{ }^{\text {a }}$ | - 5.00** | $3.41 * *$ |
| P6 |  |  |  |  |  | $0.88{ }^{\circ 00}$ | $1.26$ | $=0.69$ |
| P7 |  |  |  |  |  |  | 0.64* | $=3.54^{*}$ |
| P6 |  |  |  |  |  |  |  | $1.23{ }^{\circ 0}$ |

* SignLPIcant at Sk laval
es signipicant at is leval



Table 10
Lea effacts (diaganal) and sea uffacta (aff diagonal) far plant height in fxi diallul of opium popgy in E3

| Parnnt | $\begin{gathered} \text { P1 } \\ \text { (Tienzatak) } \end{gathered}$ | $\qquad$ $\begin{gathered} \text { P2 } \\ \text { (DCG) } \end{gathered}$ | $\begin{gathered} \text { p3 } \\ \text { (Tslía } 1) \end{gathered}$ | (Irriansan) | $\begin{gathered} 05 \\ (\mathrm{LL} 3) \end{gathered}$ | $\begin{gathered} \text { P6 } \\ \text { (up white) } \end{gathered}$ | P7 <br> (Hafamaa) | p8 (Calania) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -0.0.67 | $=0.75$ | -1.27 | 1.16 | 0.10 | 2.53 | 0.16 | 0.33 |
| P 2 |  | 2.04** | 0.22 | 3.75 | 3.09 | 0.42 | 0.65 | -0.68 |
| p3 |  |  | 0.36 | 2.33 | -3.33 | 5.809* | 1.63 | 3.40 |
| P4 |  |  |  | 9. 23 | 0.14 | -1.27 | 0.06 | -0.07 |
| P5 |  |  |  |  | 0.21 | -2.83 | -0. 10 | 2.07 |
| H6 |  |  |  |  | - | 0.24 | -0.77 | -2.50 |
|  |  |  |  |  |  |  | 0.23 | $5.03 \%$ |
| P6 |  |  |  |  |  |  |  | $-1.74=0$ |

* Signifleant at $5 \%$ lovel
* 5ignificant at $1 \%$ lavel
$\begin{array}{lll}S E(\hat{g i}) & \pm 0.67 & S E(5 \hat{j}-5 \hat{i k}) \pm 3.04 \\ S E(\hat{g i}-\hat{g} j) & \pm 1.01 & \text { SE }(5 \hat{i} j-5 \hat{j k} 1) \pm 2.09 \\ S E(\hat{i j}) & \pm 2.06 & \end{array}$

Tabla 11
Lea effects (diagonal) and aca effacts (aff diagonal), for plant height in $8 \times 8$ diallal of $=$ oplum pappy in E.4

| Parent | P1 P2 <br> (Aanzatak) (DCK) | $\begin{gathered} \text { p3 } \\ \text { (Telfa 1) } \end{gathered}$ | $\begin{gathered} \text { P4 } \\ \text { (İrianian) } \end{gathered} \begin{gathered} \text { P5 } \\ (L L 3) \end{gathered}$ | $\begin{aligned} & \text { P6 } \\ & \text { (up Mhita) } \end{aligned}$ | $\begin{gathered} \text { P7 } \\ \text { (Hapmaa) } \end{gathered}$ | $\begin{gathered} \text { P8 } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -1.1800 4.6900 | -0.65 | -0188 -2.34" | 1 5.38** | -0.67 | 2.56 ${ }^{\circ}$ |
| P2 | -6.98 ${ }^{\circ}$ | -1.85 | $4.62^{\circ \%} \quad 2.06^{\circ}$ | -3.12** | 1.43 | -3.34* |
| 13 |  | 0.51 | 0.43 3.27* | -1.37 | $2.24{ }^{\text {* }}$ | 2.17* |
| P4 |  |  | -0.96"* 0.74 | 5.76** | -4.29** |  |
| P5 |  |  | -0.10 | $9.00^{* *}$ | 1.85 | -1.92 |
| P6 |  |  |  | 2.480\% | $2.97{ }^{\circ}$ | -3.50** |
| P7 |  |  |  |  | 1. 23 | 5.4500 |
| PE |  |  |  |  |  | 0.00 |

[^2]\[

$$
\begin{array}{ll}
S E(\hat{j}) & =0.33 \\
S E(\hat{i}) \hat{g} j) & \pm 0.49
\end{array}
$$
\]

SE $(5 \hat{i} j-5 \hat{j k}) \pm \hat{2} .48$
SE $(S \hat{1} j-5 \hat{k} 1) \pm 1.40$

## Tabla 12

Bes effecte (diagonal) and sca affects (off diagonal), for plant haight in Bx日 diallel af apium pappy (over anvizonmants)

| Parant | (Ranaatak) | $\begin{gathered} \text { P2 } \\ (\mathrm{DCG}) \end{gathered}$ | $\begin{gathered} \text { p3 } \\ (T \text { alia } 1) \end{gathered}$ | $\begin{gathered} \text { P4 } \\ \text { (I trianian) } \end{gathered}$ | $\begin{gathered} \text { p5 } \\ (\mathrm{LL} 3) \end{gathered}$ | $\begin{gathered} \text { PG } \\ \text { (up Whita) } \end{gathered}$ | $\begin{gathered} \text { P7 } \\ \text { (Happmea) } \end{gathered}$ | (Galania) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | $=0.212$ | 40.87 | $-1.03$ | 2.43 | 1.38 | $3.33 *$ | 2.91 | 0.65 |
| P2 |  | $-12.277$ | 71.01 | 4.17** | 1.44 | 0.66 | 4.05** | 0.78 |
| P3 |  |  | *0.14a | 0.20 | 0.11 | D. 8 B | $4.04{ }^{*}$ | 3.00 |
| P4 |  |  |  | -0.759 | 0.39 | 3.51" | -0.94 | 0.56 |
| 95 |  |  |  |  | -0.224 | 2.13 | 0.59 | 0.93 |
| P6 |  |  |  |  |  | 0.336 | -0.02 | -0.12 |
| P7 |  |  |  |  |  |  | 1.390 | $1.43$ |
| P星 |  |  |  |  |  |  |  | $-11.104$ |

$\left.\mathrm{SL}_{(51)} \hat{1}\right) \pm 0.50$
$S C_{(5 \hat{i} \mathrm{~J})} \pm 1.53$
$S_{(S \hat{j}-\hat{S i k})} \pm 2.27$
$S_{(S \hat{j}-S \hat{k} 1)} \pm 2.14$

The luwest significant and positive sua effsct wan reonsied by $2 \times 5$ and it was found to be at par with $1 \times 2$ and $3 \times 5$.

In poolad analyals no crass racurdad signifieant negativa sce uffact but pive hybrids Vizo: $2 \times 4,2 \times 7,3 \times 7$, $4 \times 6$ and $1 \times 6$ had signipicant and pasitiva sca affacts (Table 12) HO significant differancen ax istad betwenn thesa crassas .
4. 4 LLEAF ARLA

Leaf is tha sita of photosynthesis and in upium poppy is the important aits of latex and alkalaids synthasis. More leap area io desirable in this erop.
4.4.1 Pas ge PCBF OMTANLE

The parformance of gonotypes in pooled data for this charactis revaralad the fact that the range for paranta was $170.41 \mathrm{~cm}^{2}(\mathrm{PS})$ to $130.48 \mathrm{~cm}^{2}(\mathrm{P} 7)$. The highest laaf aren of $197.72 \mathrm{~cm}^{2}$ was sacurded by $2 \times 6$ as against lowest of $1 \times 8\left(136.80 \mathrm{ci}^{2}\right)$. The parformance Ss presented in Table 13.
4.4.2 HiL TCrMSS

Dnly ssvan erosites segordad signiploant and pasitive haterosis and eight grosase reaoriad significant

## Tabla 13

Par-me performance of parants and hybrids in Exb diallal of opium poppy por leaf araa ( $\mathrm{cm}^{2}$ ) in pooled analyais

| Parant | $\begin{gathered} \text { P1 } \\ \text { (Ranzatak) } \end{gathered}$ | $\begin{gathered} \mathrm{P} 2 \\ (\mathrm{pcc}) \end{gathered}$ | $\stackrel{\text { p3 }}{(\mathrm{Talfa} 1)}$ | (Ircianian) | $(\mathrm{Ps} 3)$ | $\begin{gathered} \text { PG } \\ \text { (up White) } \end{gathered}$ | $\begin{gathered} \text { P7 } \\ \text { (HaPemen) } \end{gathered}$ | $\begin{gathered} \text { PB } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | 149.46 | 156.58 | 142.74 | 159.09 | 171.22 | 160.36 | 143.13 | 136.80 |
| $\mu_{2}$ |  | 157.29 | 158.86 | 173.54 | 193.49 | 197.72 | 167.97 | 174.72 |
| P3 |  |  | 164.98 | 163.14 | 160.26 | 147.01 | 168.34 | 175.07 |
| P4 |  |  |  | 161.56 | 163.70 | 168.51 | 186.19 | 140.36 |
| PS |  |  |  |  | 170.41 | 153.32 | 172.94 | 193.72 |
| P6 |  |  |  |  |  | 166.80 | 142.90 | 163.83 |
| P7 |  |  |  |  |  |  | 163.83 | 170.30 |
| PR |  |  |  |  |  |  |  | 130.48 |

Wotes plagonal entries for parents i off diagonal entrios for hybrids.
and nagativa hatarasis ovar battar parent. Nighento signipicant and positive heterosis was obaerved pur2x6, whils $3 \times 5$ recorded highsst, significant and nagative heteranis (Tabla 14) .

## 4.4 .3 GCA EFFELTS

10 E.1. all parental innas exeept ps had highly Bignificant gea sffacts (Tabla 15) . P2 (29.14) was Pound \&o the significantly superios to p3 ( 6.23 ) , 97 ( 6.98 ) and P4 (5.56) for positive gen efpects, but no signipicant dSffarances were proant betwesn $\mathrm{P} 3, \mathrm{H} 7$ and P4. Pq was Fgund to the signiflaantly superiar to phand PO Par nagative gea sffacts. In [2, 15 and $p 2$ had pasitive gea sffects but tware Pound ta be at par (Table 16) : Threo paranta vizepp4, P6 and P7 racurded negative and signipiaant gea aplent and were at par. In C3, all parants racovied signipicant gra offects (Tabla 17). Qut of fivo parents which racardad pasitive appacta, PA $(10.49)$ was found to be significantly superior to P2, i5 and $\mathrm{P}^{7}$, but was at par with P6. Though there exsiated no significant dipfarence batwaen p3 and pa Por negative gue offect, beth of thess were found to be significantiy infarior ta P1. In E4, faur parente vizeg P1. PS, \$6 and P3 had signifiaant gon affeats. lut of thasa anly two viz PS and lis had poaitive offact uith no aignifinant dsfforanca betwaen them. P1 ( -4.55 ) was aignifigartiy infarior to pe (Tabla 1B).

Tabla 14
Heterosis por laap aree in poolad data

Hetarasias
Crosses Guer bettor parent Uver mid parent value

| $1 \times 2$ | - 0.45.0 | $2.09$ |
| :---: | :---: | :---: |
| $1 \times 3$ | -13.48 | -9.21 |
| $1 \times 4$ | - 1.53 | $7.06{ }^{\text {a }}$ |
| $1 \times 5$ | - 3.86. | -1.41 ${ }^{\text {a }}$ |
| 1x6 | -12.64** | -8.63 |
| 1×7 | - 8.47 | -2.26 |
| $1 \times 8$ | - 3.71. | -1.41.. |
| $2 \times 3$ | -7.42.0 | 8.85.* |
| $2 \times 4$ | 13.54 \% | 18.09 .0 |
| $2 \times 5$ | $18.54{ }^{\circ}$ | 22.02 |
| $2 \times 6$ | 2.53 - | $4.62{ }^{\circ}$ |
| $2 \times 7$ | $11.08{ }^{\circ}$ | 21.43 |
| $2 \times 8$ | - 1.12. | -0.01 |
| $3 \times 4$ $3 \times 5$ | - 5.94 .0 | -11.38 ${ }^{\circ 0}$ |
| $3 \times 5$ $3 \times 6$ | -11.86 | - 2.39 .0 |
| $3 \times 7$ | 2.04. | 18.51 |
| 3x | - 3.94 | 1.38 |
| $4 \times 5$ | 1.03.* | 2.64 an |
| $4 \times 6$ | 13.65 | 14.44 |
| $4 \times 7$ | -13.12.0 | - 0.07 |
| $4 \times 8$ | $-10.03$ |  |
| $5 \times 6$ | 1.480* | 28.76.******* |
| $5 \times 7$ | 13.63.0 | -13.56* |
| $5 \times 0$ | -14.32 | 10.22** |
| $6 \times 7$ | - 1.78 | 19.73 |
| $6 \times 8$ | 3.95 |  |

- Signipicant at 5if ieval
ee significant at $1 \%$ laval

Table 15
Gea spfects (diagonal) and Sca affocts (off diagonal) for laaf araa in 8x8 diallol of oplum poppy in E1

| Parent | $\begin{array}{cc} \text { P1 } & \text { P2 } \\ \text { (Panzatak) } & \text { (DCE }) \end{array}$ | $\begin{gathered} p 3 \\ (\operatorname{Te115} 1) \end{gathered}$ | $\stackrel{P 4}{\text { (Imianian) }}$ | $\begin{aligned} & \text { PS } \\ & (\mathrm{LL} 3) \end{aligned}$ | $\begin{aligned} & \text { P6 } \\ & \text { Whits) } \end{aligned}$ | $\begin{gathered} \text { P7 } \\ \text { (HaPames) } \end{gathered}$ | $\begin{gathered} \text { Pg } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -18.83**29.14** | -30.40 ${ }^{\circ}$ | -1.73 | 40.990\% | 40.17** | -55.75** | -22.42** |
| ${ }^{2} 2$ | $14.29{ }^{\circ}$ | 10.40 | $-29.55 * *$ | 5.87 | 72.8500 | 目.33 | 54.06** |
| P3 |  | B.2300 | 29.7100 | -0.97 | -22.09** | $-48.44=*$ | $43.12^{* *}$ |
| P4 |  |  | $5.56 \%$ \% | $41.00{ }^{* *}$ | 1.08 | $39.76{ }^{\circ}$ | $-3 \mathrm{E} .71^{-\pi} \frac{1}{\mathrm{n}}$ |
| 15 |  |  |  | -1.36 | -67.8000 | $38.48{ }^{\circ}$ | $0.51$ |
| P6 |  |  |  |  | - $7.344^{\circ}$ | -68.24** | -39.19=* |
| P7 |  |  |  |  |  | 6.9800 | 22.17** |
| P9 |  |  |  |  |  |  | -6.9500 |

[^3]| SE $\hat{\text { (gi) }}$ | $\pm 1.99$ |
| :---: | :---: |
| SE10 | $\pm 3.01$ |
| ${ }^{\text {SE }}$ (5îj) | $\pm 6.10$ |

$$
\begin{array}{ll}
S E(S \hat{j} j-5 \hat{j} k) & \pm 9.02 \\
5 E(5 \hat{i} j-S \hat{k} 1) & \pm 8.50
\end{array}
$$

Table 16
Sea offacts (diagonsl) and aca sffects (off diagonal), Por laap area in Exi dinalel of opium poppy in E2.

| Parent | $\begin{gathered} \text { P1 } \\ \text { (Itanzatak) } \end{gathered}$ | $\begin{gathered} \mathrm{H}_{2} \\ (\mathrm{OCG}) \end{gathered}$ | $\begin{gathered} \text { p3 } \\ \text { (Talia 1) } \end{gathered}$ | $\begin{gathered} 94 \\ \text { (Irriansan) } \end{gathered}$ | $\stackrel{145}{(213)}$ | $\begin{gathered} \text { P6 } \\ \text { (49 Whita) } \end{gathered}$ | P7 <br> (Hapmana) | $\begin{gathered} \mu 8 \\ (\mathrm{Ga} \operatorname{san} \mathrm{a} a) \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | 4.55 | -24.04** | * $40.77^{* *}$ | 7.94 | -3.04 | $-15.29 \%$ | 1.71 | -48.06\% |
| P2 |  | $7.63{ }^{\circ}$ | * -31.69 * | 13.76 | 10.79 | $17.43{ }^{\text {F }}$ | -25.49** | 11.06 |
| P3 |  |  | - 1.98 | $21.270{ }^{\text {a }}$ | -16.38* | -13.76 | -30.? $8^{\circ 0}$ | - 1.53 |
| P4 |  |  |  | $=5.75{ }^{\circ}$ | -54.31** | 22.61** | -13.41 | $-23.96{ }^{\text {* }}$ |
| P5 |  |  |  |  | $10.20^{* *}$ | 37.36 ${ }^{\text {/4 }}$ | 4.44 | $78.49^{\circ *}$ |
| P6 |  |  |  |  |  | -5.012 ${ }^{\circ \prime}$ | 12.85 | -41.59** |
| P7 |  |  |  |  |  |  | $=8.60^{\circ}$ | -29.29** |
| Ps |  |  |  |  |  |  |  | - 1.05 |

- Significant at 5\% Laval
** significant at $1 \%$ lavel

5E(gi) $=2.44$
${ }^{5 E}(\hat{g i-g j}){ }^{2}{ }^{3.6 a}$
$\left.{ }^{3} E_{(5 \hat{j}}\right) \approx 7.47$

SE $(5 \hat{i} j-5 \hat{i k}) \neq 11.05$
$5 E_{(5 \hat{i} j-5 \hat{k} 1)} \pm 10.42$

Table 17
Bea effects (diagonal) and aca gifonta (opf diagonal), Por lnaf arae in $8 \times 3$ diallel of opiun poppy in E. 3

| Parent | $\begin{gathered} \text { pq } \\ \text { (ilanzatak } \end{gathered}$ | $\begin{gathered} \text { P2 } \\ (\mathrm{DCD}) \end{gathered}$ | $\begin{gathered} 83 \\ (\operatorname{TeLS} 1) \end{gathered}$ | $\begin{gathered} \text { ph } \\ \text { (Ixidansan) } \end{gathered}$ | $\begin{aligned} & 95 \\ & (\mathrm{LL} 3) \end{aligned}$ | $\begin{gathered} 96 \\ \text { (up Whits) } \end{gathered}$ | $\begin{gathered} \text { P7 } \\ \mathrm{Haf} \text { emaa } \end{gathered}$ | $\begin{gathered} \text { PG } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -18.76** | -15.12** | -30.44"* | 16.89 $=$ | 14.71** | 8.9500 | 18.77= | $6.38 \%$ |
| P2 |  | $5.12^{\circ 0}$ | - 3.92 | 12.5300 | 36.93*9 | 49.9730 | -21.910* | -6.90** |
| P3 |  |  | - $-9,16^{*}=$ | -21.49 \% | -31.39 ${ }^{\text {a }}$ | -15.65 ${ }^{\text {c }}$ | $77.570=$ | 22.48** |
| 14 |  |  |  | 10.49** | $-13.44^{* *}$ | 10.6037 | 0.22 | 11.03** |
| Ps |  |  |  |  | 6.79** | -25.139 ${ }^{\circ}$ | -22.3g** | 5.33 |
| ${ }_{1} 6$ |  |  |  |  |  | $7.15{ }^{\circ \prime}$ | -29.94* | 5.17 |
| P7 |  |  |  |  |  |  | $4.63{ }^{\text {c }}$ | -9.91** |
| Pa |  |  |  |  |  |  |  | -7.28** |
| Significant at 5\% laval * signifieant at $1 \%$ lavel |  |  |  | SE $(\hat{y i})$ | $\pm 0.95$ | $\begin{aligned} & 3 E^{(5 \hat{i} j-S \hat{j} k)} \\ & 3 E(5 \hat{i} j-S \hat{k} 1) \end{aligned}$ |  | 4.31 |
|  |  |  |  | SE (9i-g | $\hat{g j})^{ \pm}=1.44$ |  |  | 4.06 |
|  |  |  |  | SE (3îj) | $\pm 2.91$ |  |  |  |

## Table 18

Gea affacts (diagonal) and sca affacts (off diaganal), Por laep aroa in $8 \times 8$ diallel of opium poppy in K. 4

| Parent | $\begin{gathered} P 1 \\ \text { (Manzatak) } \end{gathered}$ | $\begin{gathered} \mathrm{P2} \\ (\mathrm{DCG}) \end{gathered}$ | $\begin{gathered} \text { P3 } \\ (\text { Telia 1) } \end{gathered}$ | $\begin{gathered} P 4 \\ \text { (Irrianian) } \end{gathered}$ | $\begin{aligned} & \text { P5 } \\ & \text { (LL.3) } \end{aligned}$ | $\begin{gathered} \text { P6 } \\ \text { (up White) } \end{gathered}$ | $\begin{gathered} \text { P7 } \\ \text { (HaP anea) } \end{gathered}$ | $\begin{gathered} \text { P8 } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -4.55* | -5.65 | -14.57* | -5.57 | -7.07 | -3.85 | -11.35 | $23.27^{* *}$ |
| P2 |  | 1.92 | -12.63 | 10.97 | 13.77* | -31.7900 | 24.1900 | $-10.49$ |
| P3 |  |  | - 4.07 | -25.45** | $20.55 \%$ | - 5.93 | 24.87eo | 20.09** |
| P4 |  |  |  | - 3.97 | $-1.55$ | $-18.93^{* *}$ | $5.37$ | $-16.37^{\circ}$ |
| P5 |  |  |  |  | $11.04{ }^{\circ}$ | $-9.63$ | $-12.13$ | $-39.21=0$ |
| P6 |  |  |  |  |  | 7.92** | $-2.01$ | $27.35=0$ |
| P7 |  |  |  |  |  |  | 3.52 | 10.11 |
| P6 |  |  |  |  |  |  |  | $-11.810 *$ |

[^4]\[

$$
\begin{aligned}
& \mathrm{SE}_{(\hat{\mathrm{j}})} \neq 2.27 \\
& 3 E_{(\hat{i j}-\hat{j} \mathrm{~J})} \pm 3.43 \\
& \mathrm{SE}(\mathrm{sij}) \pm 6.96
\end{aligned}
$$
\]

$$
\begin{aligned}
& S E_{(S \hat{i} j-\hat{S i n k})} \pm 90.30 \\
& \operatorname{SE}_{(S \hat{j} j-\hat{j k} I)} \pm 9.71
\end{aligned}
$$

In pooled analysia faur paranta had signipicant gea effiect and out of thess p5 and $\mathrm{m}_{2}$ had positiva affact with no signifigant diffarence Datween than . No significant difference was observad batwean P 1 \& P8, the two parants having negative gea eppacts (Table 19).

### 4.4.4 SCA EFFLCTS

In E.1. twanty one erossen had signipicant soa affacts (Tabla 15) - Elavan crassas recorded significant positiva sca appoets. Tross $2 \times 6(72.85)$ was found to be signipicantly suparior so the rasaining crassas. Thare extisted no significant diffurences amorig $2 x B, 3 x B, 4 x S$, 1×5. $1 \times 6,4 \times 7$ and $5 \times 7$ far positive soa effacts. Dut of ten croasas having signipicant negative sca apfacts, $3 \times 6$ Fecordad lowat affact: but was found to be at par uith $1 \times 6,2 \times 4,1 \times 3$ a $4 \times 8$. In [2, sevintean erossas had signiffcant ags offacta with only six erossas showing positive affagta (Toble 16). Highest, aignificant and positive sca effact was abservar Por $5 \times 1$ (78.49) and it was found to od highly signlficantly superiar to the seinaining crosana . Ro significant differancsa axsistad among $1 \times 3,5 \times 6,4 \times 6,3 \times 4$ and $2 \times 6$ at $1 \%$ laval of signipianca. HLghest, Algnipicant and nagative sca affant sas recovied lyy $4 \times 5$ and it wase found ta be at par with $1 \times 6$ and $6 \times 8$. There, howevas, susistad no significant differences mang

Gea affoct (diagonal) and sea apfacts (opf diagonal), for loaf araa in Exa diallel in opium poppy (0var anvironments)

| Parent | $\begin{gathered} \text { P1 } \\ \text { (Kanzatak) } \end{gathered}$ | $\begin{gathered} \text { P2 } \\ (\mathrm{OCG}) \end{gathered}$ | $\begin{gathered} \text { P3 } \\ \text { (Telia 1) } \end{gathered}$ | $\stackrel{\mathrm{P4}}{\text { (Irrianian }}$ | $\stackrel{\text { P5 }}{\text { n) }}$ | $\begin{gathered} \text { P6 } \\ \text { (up white) } \end{gathered}$ | $\begin{gathered} \text { P7 } \\ \text { (Hafemae) } \end{gathered}$ | $\underset{\text { (Gslania) }}{\text { PB }}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -9.88** | -3.69 | -6. 22 | 4.90 | 9.85 | 7.21 | -11.24* | -11.20* |
| P2 |  | $6.98^{\circ *}$ | -9.27 | 2.49 | 15.25** | 27.71 ** | - 3.26 | 9.86 |
| P3 |  |  | -2.23 | 1.29 - | -8.75 | -13.99** | 6.32 | 19.42** |
| P4 |  |  |  | 0.99 - | - 8.55 | 4.48 | 20.44** | -15.52** |
| P5 |  |  |  |  | $8.18{ }^{\circ}$ | -17.890* | 0.51 | 27.65** |
| P6 |  |  |  |  |  | 0.04 | -21.31** | 5.99 |
| P7 |  |  |  |  |  |  | 1.10 | 11.24 |
| P8 |  |  |  |  |  |  |  | - 5.19** |

* Significant at stivel
** Significant at $1 \%$ level

| $S E(g i)$ | $\pm 1.73$ | $S E E_{(5 i j-S i k)} \pm 7.84$ |
| :--- | :--- | :--- |
| $S E_{(g i-9 j)} \pm 2.61$ | $S E(S i j-S k I)$ | $\pm 7.40$ |
| $S E(S i j)$ | $\pm 5.30$ |  |

athar erossab having nigative bas offacts. In ES, tuenty Pour erasses had esgnificant aca affacts with twolva having pasiefve effacta (Tabla 17) . Grosa $3 \times 7$ (77.57) racordod nighest, significant and positive sca effect and was found to ba suparinr to tha rainaining grassas . Next in arder ap significance wara $2 \times 6(49.97)$, $2 \times 5(36.93)$ and $3 \times 8$ ( 22.48 ). Loesst negative and significant sea effeat was abserved for $2 \times 8$ ( 08.90 ) but it did nat SLPPer algnificantly from 7x5, 4×5. $1 \times 2$ and $3 \times 6$. In EA, out of sevantann significant crasses for sca affucts, seven crossea vizo, $6 x$, $3 \times 7,2 \times 7$, 1×日, $3 \times 5$, $3 \times 8$ and $1 \times 5$ sacorded significant positiva effuctan and thara exsistad no signifiaent difference betuan theae soven crosses (Table 18). Dut of six arasses having negative saa offecta, 5xi was signifiantly suparior ta resaining orasses, thich ware also of par.

In pooled analyais, gut of slavan significant eronses only five vize $2 \times 6,5 \times 3,4 \times 7,3 \times 8$ and $2 \times 5$ had positive saa nffacts (Table 19) - Ho aignificant diffarences were present aseng these Plve orasses . Lowest and significant nagative aca offact was racordad by $1 \times \operatorname{la}$ and it wes Pound ta bes at par with athar oroases.
A. 5 STEN DINMETEN

Latak, ones manufactured at leaf ulto io
translocated thraugh stam to peduncle and capsule whare it it atored and at a lator date lanced and taken out (Fairbrain et ai 1974). Thick atam impart antilodging charactes in opium poppy, which is a common Peatura at the time of lancing and collaction aperations. Tharafara, gea and saa eppects in positive diraction aro desirable.


P2 ( 0.65 cm ) was the thickast stan parant while P4 had the lowest sten diameter (0.52). The sange in erosses haing 0.77 gm Par $2 \times 8$ to 0.55 for $5 \times 8$ (Tabla 20).
4.5.2 HE TEROSIS

Twanty Pour crosses racordad aigniPicant haterosis over battar parent, out of which savantann shased positive hetorusis (Table 21). Highest, signipicant and positive hatesusis over bettor parant was recorded by $4 \times 6$.

## 4.5 .3 LCA EFFECT

In E4 PIVe parants racorded signifieant gat apfact and aut of thess thrae viz*, P7, P2 and Pa recorded positive offacts (Tabla 22) . Thura axisiatad na significant dAffaranaes betsean thase thras parants. The paranta 4 having nepabive gea uffact warn also at gar .

Tabla 20
Pat 旦 Perforisanes of paranta and hybsids in $8 x 8$ diallol of opium poppy，for，stan dianeter（cm） In E4

| Parent | P1 <br> （Ranza tak） | $\begin{gathered} P 2 \\ (0 C A) \end{gathered}$ | $\begin{gathered} \text { P3 } \\ \text { (Talia 1) } \end{gathered}$ | $\stackrel{\mathrm{PA}}{\text { (Irrianian) }}$ | $\mu 5$ <br> （LL．3） | $\begin{gathered} \text { 际 } \\ \text { (山िp Whits) } \end{gathered}$ | $\begin{gathered} \text { P7 } \\ \text { (NaP日maa) } \end{gathered}$ | P8 <br> （Galania） |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | 0.63 | 0.96 | 0.59 | 0.56 | 0.56 | 0.58 | 0.67 | 0.62 |
| P2 |  | 0.65 | 0.56 | 0.62 | 0.67 | 0.58 | 0.72 | 0.77 |
| p3 |  |  | 0.55 | 0.72 | 0.61 | 0.58 | 0.67 | 0.76 |
| P4 |  |  |  | 0.52 | 0.68 | 0.67 | 0.67 | 0.61 |
| P5 |  |  |  |  | 0.54 | 0． 5 a | 0.59 | 0.55 |
| P6 |  |  |  |  |  | 0.52 | 0.61 | 0.62 |
| P7 |  |  |  |  |  |  | 0.61 | 0.64 |
| P8 |  |  |  |  |  |  |  | D． 60 |

Reter Diagonal antriea Par parants；pff diagonal antries For hybride．

## Tabla 21

Hetarosis for atum dianater in EA

## Heteroalas

Crossses bug better parant iver mid perant value

1×2
1×3
$1 \times 4$
$1 \times 5$
$1 \times 6$
$1 \times 7$
1x0
$2 \times 3$
$2 \times 4$
$2 \times 5$
$2 \times 6$
$2 \times 7$
$2 \times 1$
$3 \times 4$
$3 \times 5$
$3 \times 6$
$3 \times 7$
$3 \times 8$
$4 \times 5$
$4 \times 6$
$4 \times 7$
$4 \times 3$
$5 \times 6$
$5 \times 7$
$5 \times 8$
$6 \times 7$
$6 \times 1$
7×8
$-13.85^{* *}$

- $6.34^{* *}$
$-11.11^{* *}$ 4.76
$-7.94^{\text {a }}$
$6.35^{\circ \mathrm{em}}$
- 1.58
$-13.65^{\circ}$
- $4.62^{\circ \circ}$ $3.03^{\circ}$
$-11.77^{\circ}$ 10.77
18.46**
$30.91^{\circ}$

10. 91 $5.45^{\circ 0}$ $9.84^{\circ "}$
$26.67^{\circ 0}$ $25.93^{\circ \circ}$ $28.85^{* *}$ $9.64^{* *}$ 1.67 $7.41{ }^{10}$
$-3.28^{\circ}$

- $8.33^{\circ}$ b 3.33* $4.92^{\text {e* }}$

$$
\begin{equation*}
-12.50^{\circ 0} \tag{0}
\end{equation*}
$$

- $2.611^{\circ}$
12.82"
- 0.87日.06"* 0.81
$-6.67^{\circ}$ $5.98^{\circ \circ}$ $12.60^{\circ 0}$
- 0.85
$14.29 * *$
$23.20^{* *}$
34.53**
$11.93=0$
B.41"*
$15.52^{* *}$
32.17
$23.31^{\circ}$
$20.85^{\circ}$
$18.55^{\circ}$ 8.93** $9.43^{\circ}=$ $2.61^{\circ}$
- $3.51^{\circ}$
$7.96^{\circ \prime \prime}$
$10.71^{\circ 0}$
$5.79^{\circ \circ}$

Significant at $5 \times$ laval e- Signipiaant at $1 \%$ leval

## Table 22

Gea effect (diagonal) and sca effects (opf diagonal), for stem diameter in $8 \times 8$ diallel of opium pappy in E4

| Parent | P1 (Ranzatak) | $\begin{aligned} & P_{2} \\ & (D C G) \end{aligned}$ | $\begin{gathered} \text { P3 } \\ \text { (Telia 1) } \end{gathered}$ | $\begin{gathered} \mathrm{P4} \\ \text { (Irrianian) } \end{gathered}$ | P5 <br> (LL3) | P6 <br> (UP White) | $\begin{gathered} 97 \\ \text { (Hafamea) } \end{gathered}$ | $\begin{aligned} & \text { PB } \\ & \text { (Galania) } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -0.009 | -0.072** | -0.023 | -0.059** | 0.064** | 0.00 | $0.037 *$ | -0.011 |
| P2 |  | $0.019 *$ | .081** | 0.019 | 0.046** | -0.028 | -0.059** | $0.111^{*}$ |
| P3 |  |  | 3.00 | 6.100** | 0.005 | -0.009 | 0.028 | 0.120** |
| P4 |  |  |  | -0.002 | 0.077** | 0.083** | 0.930 | -0.028 |
| P5 |  |  |  |  | -0.017** | - 0.008 | $0.059 * *$ | -0.073** |
| P6 |  |  |  |  |  | -0,033** | 0.001 | 0.013 |
| P7 |  |  |  |  |  |  | 0.020** | -0.020 |
| Pa |  |  |  |  |  |  |  | $0.018^{* *}$ |

* Signipicant at $5 \%$ level
* Significant at $1 \%$ level

$$
\begin{array}{ll}
S E(\hat{g i}) \pm 0.005 & \left.S E_{(S \hat{i} j-S \hat{i} k}\right) \pm 0.024 \\
S E(\hat{g i n}-g \hat{j}) \pm 0.008 & S E(\hat{j i j}-S \hat{k} 1) \pm 0.023 \\
S E(S \hat{i}) \pm 0.017 &
\end{array}
$$

### 4.5.4 SCA EFRLLTS

Of the Pourtean significant crassen for sad effect in E.4, nine had positive offeess (Table 22). Tio signipicant dsfferences ware observed among these erasses. Cresaas having negative effects, wart also at par e

### 4.6 NUFBER UT CAPSULES PLA PLANT

Rumber of capsulas per plant cantributa to yiald componants in major craps. Thís character can increase seod yiald in opium poppy (Jablonski, 1967). In opium poppy it is the terminal and main capsula which cantritiutas to tha Ifon share of latox yiuld (Gupta gt aIs, 1978), and tharapore, In the presant investigation alan, this tharactar eas studied and pasitiva gea and sea effact hava bean sumasisad below -

## 

prosantad in tabla 23 . p3 (2.15) had highast numbar of cepsulas per plant whila P1 (1.67) had lawest value. Tha sange of numbes of capoules par plant in hybitia waa fran $2.47(4 \times 6) \$ 04.70(1 \times 7)$.

Per ge Perforasnce of paranta and hybrids in 自x diallal of opium poppy, for number of capsules per plant in pooled anelysis

| Parent | $\begin{gathered} \text { P1 } \\ \text { (Hanzatak) } \end{gathered}$ | $\begin{gathered} P 2 \\ (\mathrm{DCLG}) \end{gathered}$ | $\begin{gathered} \text { E3 } \\ \text { (Talia 1) } \end{gathered}$ | $\begin{gathered} \mathrm{PA}_{\text {(Irrianian) }} \end{gathered}$ | $\begin{gathered} p 5 \\ (L L L 3) \end{gathered}$ | $\begin{gathered} \text { P6 } \\ \text { (up whits) } \end{gathered}$ | $\begin{gathered} \text { P7 } \\ \text { (HaPemua) } \end{gathered}$ | $\begin{gathered} \mathrm{Pg} \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | 1.67 | 2.12 | 1.91 | 1.89 | 1.87 | 2.33 | 1.70 | 2.05 |
| \#2 |  | 1.63 | 1.86 | 2.16 | 2.31 | 2.12 | 1.99 | 1.99 |
| P3 |  |  | 2.15 | 1.97 | 2.08 | 2.28 | 1.99 | 2.09 |
| P4 |  |  |  | 1.99 | 2.39 | 2.47 | 1.88 | 2.22 |
| P5 |  |  |  |  | 1.as | 2.01 | 2.17 | 2.45 |
| P6 |  |  |  |  |  | 1.87 | 2.03 | 1.83 |
| ${ }^{+7}$ |  |  |  |  |  |  | 1.99 | $1.91$ |
| PE |  |  |  |  |  |  |  | 1.85 |

Natat - Diagonal antrias for parants off diaganal entriat Par hyorids.

Faurtaen cruases had signipicant heterosis ovar better parunt and out of thase sight had positive effoct (Table 24) . The cross $4 \times 6$ recorded highest positivo heterasis whila lausst nagative afpact uas absarvad for 2x8

## 4.6 .3 GCA EFFLCTS

In L2, all parants rocardod signipieant gea appects and aut of these pive parents had positiva uffacta (Table 25) . $P 4(D, 22)$ was faund to bo aignsplenntly auparior to the ramaining parants for gea sffeeta axeapt p5 (0.19) Prani which it did not diffar significantiy. p2 having nagative affact tase found to ba algnificantiy superior to $\mu 2$ and $\mu 3$. In E3, andy P2 (0.12) had signifigant and pusitive gaa apfact (Table 26).

In pooled analysia only four parents had adgnifloant gea affadts (Tabla 27) - Linly P4 and ps had positive effegt but thare axsistad na aignificant diffaranas betwaan then. Tha athar twa parants having negative appact were found to ba at par.

Table 24
Heterosis far number of capsules per plant (pooled da\&a)

## Hatarasis'

Ceasses duer to tter parent Quer mid parisnt value

| 1×2 | $13.19{ }^{3}$ | 14.79** |
| :---: | :---: | :---: |
| 1×3 | - 8.11 | 6.75 |
| $1 \times 4$ | - 4.40 | 7.59 |
| $1 \times 5$ | 15.38 \% | 20.00** |
| $1 \times 6$ | -19.25\% | - 0.76 |
| 1×7 | -190 | 6.80 |
| 1×B | $-19.46^{*}$ | - 6.31 |
| $2 \times 3$ | -19.46 | $-12.42^{* *}$ |
| 2x4 | 25.79** | $33.780 \pm$ |
| 2×5 | 3.21 | 6.78 |
| $2 \times 6$ | $-15.51{ }^{\circ 0}$ | - 3.36 |
| 2×7 | -11.52 | - 4.26 |
| 2x8 | -21.62** | -20.99*4 |
| $3 \times 4$ | - 5.41 | 1.74 |
| $3 \times 5$ | - 0 | - 8.50 |
| $3 \times 6$ | -6.42 | - 5.91 |
| $3 \times 7$ | - 0.42 | 6.85 |
| $3 \times 8$ | 30.22** | $39.00^{\circ *}$ |
| $4 \times 5$ | 43.96 ${ }^{\text {a }}$ | $55.03^{\circ}$ |
| $4 \times 6$ | -12.83** | -11.65** |
| $4 \times 7$ | -12.03 | 10.09 |
| $4 \times 8$ | 4.95 | 7.94 |
| $5 \times 6$ | 9.63* | 18.50** |
| $5 \times 7$ | 33.3300 | $35.00^{\circ}$ |
| 5x8 | $10.16^{\prime \prime}$ | 20.12** |
| $6 \times 7$ | 10. 5.03 | - 0.31 |
| $6 \times 8$ | -3.21 | 2.64 |
| $7 \times 8$ |  |  |

- Signipicant at 9\% Luval * Signipicant at $1 \%$ level


## Table 25

Gea effect (diagonal) and aca affects (off diagonal), Par numbar ap eapsules par plant in Bxe diallel of apium poppy in C 2

| Parant | $\begin{gathered} \mu 1 \\ \text { (Ranzatak) } \end{gathered}$ | 中2 <br> (OCE) | $\begin{gathered} \text { P3 } \\ (\text { Telia 1) } \end{gathered}$ | $\begin{gathered} \mathrm{P} 4 \\ (15 \mathrm{sianian}) \end{gathered}$ | ps <br> (LL.3) | P6 <br> (up Mhita) | 『7 <br> (HaPeman) | $\begin{gathered} \text { PQ } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -0.26** | 0.19 * | -0.06 | -0.08* | $-0.20{ }^{\circ}$ | -0.01 | -0.35** | -8.24** |
| P2 |  | -0.420* | -0.110 | -13.24** | -0.15** | -0.20** | -11.09* | -0.22** |
| 13 |  |  | -0.05** | -0.70** | -0.06 | -1.04 | -0.19* | 0.39** |
| P4 |  |  |  | $0.22 * *$ | 10.43*0 | 1.22** | -0.59** | $-0.23{ }^{*}$ |
| 95 |  |  |  |  | 0.19** | $-0.22^{\circ 0}$ | 10.44** | 0.71 ** |
| P6 |  |  |  |  |  | $0.16^{\circ *}$ | $0.43 * *$ | -20.250= |
| P7 |  |  |  |  |  |  | 10.120e | 0.01 |
| pl |  |  |  |  |  |  |  | $0.04 * *$ |

* signipicant at $\%$ lavai
** Significent at $1 \%$ laval

```
SE}(\hat{g2})=0.012
\({ }^{3 E}(\hat{g}-\hat{g} \mathrm{j}) 2^{0.0195}\)
\[
5[(S \hat{i} j) \quad \pm 0.0395
\]
```

$S_{(S \hat{i} j-S \hat{i} k)} \neq 0.0535$
SE $(S \hat{i} j-S \hat{k} 2) \neq 0.0551$

Table 26
Gea effact (diagonal) and aca affects (off d!agonal), for number of capsules per plant in fix diallel of oplum poppy in E3

| Parant | (Ranza | $\begin{aligned} & P 2 \\ & (D C G) \end{aligned}$ | $\begin{gathered} \text { P3 } \\ \text { (Telia } 1 \text { ) } \end{gathered}$ | $\begin{gathered} \text { FA } \\ \text { (Inciandan) } \end{gathered}$ | P5 <br> (2L3) | $\begin{gathered} \text { P6 } \\ \text { (uf White) } \end{gathered}$ | $\begin{gathered} \text { P7 } \\ \text { (HaPomea) } \end{gathered}$ | $\begin{gathered} \text { PQ } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -0.01 | 0.12 | 0.26 | 0.04 | -0.01 | 0.25 | 0.07 | $0.30 \%$ |
| P2 |  | 0.12 | -0.07 | 0.29* | Q. $72^{\circ 0}$ | 0.38 | -0.04 | -0.01 |
| P3 |  |  | -0.01 | -0.12 | - 4.10 | 0.18 | 0.08 | -0.11 |
| F4 |  |  |  | 0.05 | $0.30{ }^{\circ}$ | 0.045 | 0.81 | 0.23 |
| 95 |  |  |  |  | 0.02 | -0.21 | -0.12 | -0.03 |
| P6 |  |  |  |  |  | -0.036 | 0.00 | -D. 16 |
| P7 |  |  |  |  |  |  | -0.06 | 0.09 |
| Pis |  |  |  |  |  |  |  | -0.04 |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |

Gee effect (diagonal) and sca gefects (off diagonal), for number of capsules per plant in Eme diallel of opfum poppy (Ovar onviranments)

| Parent | $\begin{gathered} p 1 \\ \text { (Ranzatak) } \end{gathered}$ | $\begin{gathered} \mathrm{P}_{2} \\ (\mathrm{DCG}) \end{gathered}$ | $\begin{gathered} \text { P3 } \\ (T \in 15 a 1) \end{gathered}$ | $\begin{gathered} \text { P4 } \\ \text { (Irrianian) } \end{gathered}$ | $\begin{aligned} & p 5 \\ & (\mathrm{LL} 3) \end{aligned}$ | $\begin{gathered} \text { PG } \\ \text { (up WhAtes) } \end{gathered}$ | $\begin{gathered} \text { P7 } \\ \text { (HaPamaa) } \end{gathered}$ | $\begin{gathered} \text { P8 } \\ \text { (Calania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -0.131** | 0.143 | 0.100 | -0.021 | -8. 102 | 0.120 | -0.147 | 0.026 |
| P2 |  | -0.147** | -0.094 | 0.065 | $0.284^{*}$ | -0.054 | -0.051 | -0.148 |
| P3 |  |  | -0.029 | -0.413"* | -0.082 | 0.068 | -0.009 | 0.144 |
| P4 |  |  |  | 0.13200 | U.377** | 0.677** | -0.290* | 0.023 |
| P5 |  |  |  |  | $0.10{ }^{\circ}$ | 0.212 | 0.169 | 0.344 |
| P6 |  |  |  |  |  | 0.351 | 0.221 | -0.206 |
| P7 |  |  |  |  |  |  | 0.328 | 0.027 |
| Ps |  |  |  |  |  |  |  | -0.005 |

- SIgnifieant at 5\% laval
** 5igniflcant at $1 \%$ laval

| ${ }^{\text {SE }}$ ( $\mathrm{gi}_{\text {i }}$ | 0.04437 |  | $\pm$ | 0.20125 |
| :---: | :---: | :---: | :---: | :---: |
| ${ }^{5 E}(\underline{g} \hat{i}-\hat{g})^{\text {a }}$ | 0.06708 | ${ }^{3 E}(5 \hat{1} \mathrm{~J}-\mathrm{S} \hat{k} \mathrm{l})$ |  | 0.18974 |
| ${ }^{\text {SE }}$ (5inj) | 0.13609 |  |  |  |

## 4.6 .4 SCA EFFECTS

In E2, twanty thrae arossas (Savan oith poaitive affoct) had significant sea affocts (Tabla 25). The oross $4 \times 6$ (1.22) racorded the nighest and signipicantly positive aca effect as compared to gemaining croasss . Hext in order of masit was $5 \times 8(0.71)$. Groas $3 \times 4(-.70)$ was aignificantly auperias to all othar hybrida. In E3, only four hybrida, all having positive sca apfact, were signipicant (Tabla 26). Crose $2 \times 5(0,72)$ was pound to be signifieantiy supariar to the somaining erasses ( $1 \times 8,4 \times 5,2 \times 4$ ), which in tuen waze at par -

In pooled analysla, anly six arosess racorded signifficant sea offocts (Table 27). Uut of Pous oranses having pasitive oppect, though $4 \times 6$ recordad highast and eignificant sca effect, was pound to be at par with axs and $5 \times 6$. Ko significant difforance exThed betasen $3 \times 4$ and $4 \times 7$, the orasses naving nagative sea bpfacts .
4.7 Capsule S12E

In India capoula ia generaily lanced verticaliy downwasd and sumptine 5 to 6 laneing on a aingle eapsule are affactad, this more area is requirad to accomodate Qreatas number af lanalings . posiciva gea and sea affaeks,
therefore are dasirable in opium poppy for thin charactar .

### 4.7.1 Pag se PERFDTMANLE

p7 ( $15.27 \mathrm{cn}^{2}$ ) recorded the ifghest capsula siza as against the lousst of PB $\left(13.04 \mathrm{~cm}^{2}\right)$. Among erossas, $4 \times 7$ had the highest mean $\left(16.18 \mathrm{~cm}^{2}\right)$ as compared to the 1avest of $2 \times 5$ (Tabla 28) .
4.7.2 HETERDS 15

Out of sixtean grossas which had signiflenet haterasis over batter parent, only one (7xa) recorded negative heterosis (Table 29) . Higheet, aignsficant and positive hekerosis over better parent was racorded by $7 \times 6$.
4.7.3 GCA LTFECTS

Except P2, all perants had aignificant gea opfocta In E1 and positiva affocta wera recordad by P7, P6 and P3. P7 ( 0.84 ) was aignifleantily superiar to P6 and p5, wut P6 was found to be superior to PS (Table 30). Lowest and aignificantly nugative gea affact asas absarvad far P1 . In E2, flve parenta had aignifleant gea affocta (Tabia 31). 197 (1.49) was found to bignificantiy auperior to andy other algnipicant and pooltsve offect parant pl3 (0.64).

## Table 28

Por as performancu of parant and hybrids in $B x B$ dialial of opium poppy for capauls sizs $\left(\mathrm{Cm}^{2}\right)$ in poolsd anslyais

| Parant | $\begin{gathered} \text { PI } \\ \text { (fanzatak) } \end{gathered}$ | $\begin{gathered} \text { P2 } \\ \text { (OCG) } \end{gathered}$ | $\begin{gathered} \text { P3 } \\ \text { (Telia 1) } \end{gathered}$ | $\stackrel{\text { P4 }}{\text { (Irrianian) }}$ | $\begin{gathered} \text { PS } \\ \text { (LLS) } \end{gathered}$ | P6 <br> (up whita) | $\begin{gathered} \text { P7 } \\ \text { (Hapame) } \end{gathered}$ | $\begin{gathered} \text { pB } \\ \text { (ualania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | 13.62 | 14.93 | 13.96 | 14.13 | 14.25 | 15.27 | 14.63 | 14.46 |
| P2 |  | 13.65 | 14.80 | 14.34 | 15.87 | 15.02 | 15.30 | 14.08 |
| P3 |  |  | 14.17 | 15.00 | 15.10 | 14.90 | 15.96 | 14.18 |
| P4 |  |  |  | 13.82 | 14.13 | 14.16 | 16.18 | 14.85 |
| P5 |  |  |  |  | 13.59 | 14.09 | 15.33 | 14.76 |
| 186 |  |  |  |  |  | 13.12 | 16.04 | 13.84 |
| P7 |  |  |  |  |  |  | 15.27 | 13.91 |
| P8 |  |  |  |  |  |  |  | 13.04 |

Hotet- DSugunal anveite for parmata; off diagonal uncries for hybsids.

Table 29
Hoturosis Por capsule size (poolad data)


- Signifieant at 50 level e* Sipnificant at $1 / 5$ level

Table 30
Eea effacts (diagonal) and sca affocta (off diagonal) far capsule aize in gxB diallel of upiue pappy in E1

| Parant | P1 | $p 2$ | P3 | P4 | P5 | P6 | P7 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |


| P1 | - $0.07{ }^{\circ}$ | -0.32** | 0. 13 | 0.8200 | $0.24{ }^{4}$ | 3.00** | -10.02 | -0.63 ** |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P2 |  | -9.06 | 1.27** | 0.11 | $0.25^{\circ}$ | 1.29** | -0.63 * | -1.14** |
| PY |  |  | $-0.65^{* *}$ | -0.290* | -0.33** | 0.110 | -0.13 | -0.04 |
| P4 |  |  |  | $-2.20{ }^{\circ 0}$ | -0.29** | 1.67** | 1.29** | 0.10 |
| PS |  |  |  |  | $0.21{ }^{\circ}=$ | -0.13 | 1.2504 | 0.54" ${ }^{\text {a }}$ |
| p6 |  |  |  |  |  | $0.32{ }^{\circ}$ | 0.29** | -0.132** |
| P7 |  |  |  |  |  |  | $0.84 *$ | $0.66^{* *}$ |
| P6 |  |  |  |  |  |  |  | -0.450\% |

- Signipicant at 5)/ Lavel
* Significant at is level

$$
\begin{aligned}
& 5 E(\hat{i}) \pm 0.0349 \\
& 5 E(\hat{i}-\hat{g} j) \pm 0.0527 \\
& S E(9 \hat{i j}) \pm 0.1069
\end{aligned}
$$

$\begin{array}{lll}\text { SE }(5 \hat{i} j-5 \hat{j} k) & \vdots & 0.1582 \\ S E(S \hat{j} j-5 \hat{k} 1) & \pm & 0.1491\end{array}$

## Table 31

Gea effects (diagnal) and sca affecta (off diagonal) for capsule sizo in $8 \times 8$ diellol of oplum poppy in E2


- Significant at 5\% level
**5ignipicant at 1\% laval

There ax ifatad no siynificant differencas amang parants having negative and significant effocts . In $\mathrm{E}, \mathrm{B}$, all parents except p 5 had aignificant gea affects, with only three parents vize, P3, PB and P1 having positive eppacte (Tablo 32) - P3 (0.31) was Pound ta do significantly auperior to $\mathrm{PB}(0.19)$ and Pl (0.14), howaver, P8 and PY wava at par . No aignipicont diffesancen were prusent aiaong crosses having negative gea effects. In E4, only Pour parenta (two anch with positive and nugative affects) had significant gea epfacta (Table 33). Wo signipicant difference wero observad either between parenta having positivs affacta or paranta having negative affoctn.

In pooled analysia only P7 (having posithvo affect) and PG (having nagative offacta) onee significant for gea ef racts (Table 34).

### 4.7.4 SLA EFTEGT3

In E1, out of tennty crosase having significant gon offects, aa many as twalve racorded aignipioant and posifiva sce sffacta (Table 30). Crass $\mathbf{1 \times 6}$ ( $\mathbf{3}, 00$ was signifionntly aupogior to the ramaining arosaen . Cross Axb was naxt in merit and was found to be supertor ta athar erosess - Hybrid 4X5, though racordad lousest negative sea opfact, was Pound to the at par with $3 \times 4,1 \times 2$ and $3 \times 5$.

Table 32
Gea effoct (Diagonal) and sca affects (opf diagonal) Por apaula aize in Exs diollal of oplun poppy in E3

| Paront | $\begin{gathered} \text { P1 } \\ \text { (fianzetak) } \end{gathered}$ | $\begin{aligned} & \mathrm{P2} \\ & (\mathrm{DCG}) \end{aligned}$ | $\begin{gathered} \text { p3 } \\ \text { (Telia } 1 \\ \hline \end{gathered}$ | 1) (Ixrianian) | $\begin{aligned} & p 5 \\ & (L 13) \end{aligned}$ | (up P6 Whits) | $\begin{gathered} \mathrm{p7} \\ \text { (Haremea) } \end{gathered}$ | $\begin{gathered} \text { PB } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{9} 1$ | $0.14^{\circ 0}$ | 1.69** | -0.53 | 0.10 | -0.52** | $2.22^{\text {n* }}$ | $0.25{ }^{\circ}$ | 0.09 |
| P2 |  | -0.11** | -0.08 | -0.05 | $0.87{ }^{\circ 0}$ | 0.47** | -0.40 ${ }^{\circ}$ | 0.54** |
| 93 |  |  | $0.310 \times$ | -0.27* | 1.01** | -0.45"。 | 0.5a** | 0.92** |
| P4 |  |  |  | -0.12** | $0.24{ }^{\circ}$ | -0.22 | 0.51** | 0.75 |
| P5 |  |  |  |  | 0.00 | 0.06 | 0.15 | -1.07 |
| P6 |  |  |  |  |  | -0.14** | 0.73 ** | $1.77^{\circ *}$ |
| P7 |  |  |  |  |  |  | -0.27** | $0.50{ }^{\circ 05}$ |
| Ps |  |  |  |  |  |  |  | 0.1900 |
| - Significant at 5 lovel. <br> ** Signipicant at $1 / \sqrt{6}$ leval. |  |  |  | $\begin{array}{ll} S E(\hat{n}) & \pm 0.0376 \\ S E(\hat{Q 1}-\hat{j}) & \pm 0.0569 \\ S E(5 \hat{j}) & \pm 0.1154 \end{array}$ |  |  | $\begin{aligned} & (5 \hat{i} j-\hat{j i k}) \\ & (5 \hat{j} j-5 \hat{i k}) \end{aligned}$ | $\begin{aligned} & \pm \quad 0.1700 \\ & \pm \quad 0.1610 \end{aligned}$ |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |

Table 33
Gon offect (Diagonal) and sca affacts (aff diagonal) Por capoule size in axs diallal of opium poppy in E4


Eee uffect (Diagonal) and sca effects (off diagonal) for napsule aize in Bx8 diallel of opium pappy (aver enviramaent)

| Parent | $\begin{gathered} \text { p1 } \\ \text { (Manzatal) } \end{gathered}$ | $\begin{aligned} & P_{2} \\ & (\mathrm{DEG}) \end{aligned}$ | $\begin{gathered} \text { p3 } \\ \text { (Talia 1) } \end{gathered}$ | $\stackrel{\text { P4 }}{\substack{\text { PS } \\ \text { (ITABSan) } \\ \text { (LL3) }}}$ | $\begin{gathered} \text { PG } \\ \text { (up White) } \end{gathered}$ | $\begin{gathered} \text { P7 } \\ \text { (HaPemea) } \end{gathered}$ | $\begin{gathered} \text { P8 } \\ \text { (ūalania } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -1.20 | 0.53 | -0.52 | -0.22 0.05 | 0. $0.99 *$ | - 0.42 | 0.59 |
| $\mathrm{Hz}_{2}$ |  | -0.03 | 0.15 | $0.32-0.50$ | 0.07 | 0.09 | 0.04 |
| H3 |  |  | 0.15 | $0.30 \quad 0.55$ | 0.27 | 0.57 | $=0.04$ |
| P4 |  |  |  | $0.02-0.29$ | -0.34 | 0.92* | $0.76{ }^{\circ}$ |
| P5 |  |  |  | -0.13 | 0.46 | 0.22 | 0.82* |
| P6 |  |  |  |  | -0.05 | $0.84 *$ | -0.18 |
| P7 |  |  |  |  |  | 0.71* | $-0.38{ }^{\circ}$ |
| PE |  |  |  |  |  |  | 00.46"* |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

In E2, elevan croases (Pive with positsyu afracts) racordad Bignipleant sca effacts (Table 31) . Guaparison anong crasaen having pasitiva affects revalad that eross $1 \times \mathrm{xa}$, though did not diffar bignificantly fron $4 \times 7$, was pound to be significantly auperior to tha reaaining arasaes. Ho significant dipforencos axsisted betieasn thene ramaining crosses. Crosa $7 \times 6$ racorded highest, significant and negative aca offect as compares to all ather croases. The reaaining nagative offoct erossas wern found to be at par . In [3, ninataen crosses (Fourtaen with pasitive effecta) had significant sca effecta (Table 32). Cress $1 \times 6$ (2.22) was ilgnificanfleantly superior ta the remaining crosses which had positives sea effects . It was followed by $6 \times 3(1.77)$ and $1 \times 2(1.69)$ which did not dippor signipicantiy amang thamselves. All tho fivo ernsaen having nagativo aca uffacts ware at par. In E4, only asoht araaseas rocordad significant aca affecte (Table 33) . Four crassas viz.o $5 \times 6,3 \times 6,3 \times 5$ and $5 \times 6$ recordod significant and positive sea af focts and there bxaiatad no aignificant differences anong themsalvaa . Wa aignificant difforancen wesm obsarvad among crassos having nagativa soa apfacta .

In paoled analyain, anly alx crosaes recordad algnificant sca effacta (Table 34). Dut of thase Pive erasses vize: $1 \times 6,4 \times 7,5 \times 6,6 \times 7$ and $4 \times 6$, recorded signiflcant and gesitive and oniy $7 \times 8$ racarded algnificant and negative
sca effact. No significant differences were observad among these crosses.
4.8 NUMGER DF STIGMATIC RAYS

### 4.8.1 Par se PERFORMANCE

Among the parents highest and lowest mean values were recorded by $P 7(13.70)$ and $P 6$ (12.65) respectively. Highest and lowest values amang the crosses were observed Por $5 \times 74(14.32)$ and $1 \times 3$ (12.88) raspectivaly (Table 35).。
4.0 .2 HE TCROS 15

## Out of twenty four signipigant crosaes far

heterosis over better parent, only nine had positive heterasis values. Highest positive heterasis over better parent was observed for $5 \times 7$ (Table 36).

### 4.8.3 GCA EFFECTS

In E2, six parents recorded significant gea
affect and out of these three had positive effects (Table 37). P4 $(0.27)$ was significantly superior to $P 2$ and $P 7$, and no signipicant difference was obsarved betwesn P2 and P7. Signipicantly lowest nagative gae effect was recorded by P5. In E4, all parents had signipicant gea epfects with only thres parsents vize, $P \mathrm{~B}, \mathrm{P7}$ and PG having positive effeuts

## Table 35

Per-Bi perforuance of perento and hybriss in axa diallel of opium poppy for nurber of stigmatic rays/capsule in pooled analysis

| Preront | (Ranzatak) | $\left(\begin{array}{c} P 2 \\ (D C K) \end{array}\right.$ | $\begin{gathered} \text { p3 } \\ \text { (Telie 1) } \end{gathered}$ | $\begin{array}{c\|c} \text { P4 P5 } \\ \text { (Irrianian) (Li.3) } \end{array}$ | $\begin{gathered} \text { P6 } \\ \text { (up Whits) } \end{gathered}$ | $\begin{gathered} p 7 \\ \text { (Hafanca) } \end{gathered}$ | $\begin{aligned} & \text { Pa } \\ & \text { (Calania) } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 191 | 13.35 | 13.53 | 12.05 | 13.41 13.05 | 13.52 | 13.20 | 12.89 |
| P2 |  | 13.54 | 13.41 | 13.43 13.27 | 13.63 | 13.59 | 13.78 |
| Ps |  |  | 13.43 | 13.16 13.22 | 13.53 | 13.20 | 13.50 |
| 194 |  |  |  | 13.63 13.50 | 13.62 | 13.58 | 13.76 |
| P5 |  |  |  | 13.1? | 13.31 | 14.32 | 13.79 |
| P6 |  |  |  |  | 12.65 | 13.57 | 13.55 |
| P7 |  |  | - |  |  | 13.70 | 13.48 |
| P6 |  |  |  |  |  |  | 13.41 |

Hote: Dfegonal entrine Por parants; off diagonal entries Par hyaride.

Table 36
Heterosit for number of atigiatio raye per capeula (poolad data)

## Hatargais 5

Crussea Over better parent Ivar inld parant value


[^5]
## Table <br> 37

Siea offects (diagonal) and sca effecto (off diagonal) Por number of atignatic rays/capsule in Bxi diallel of opium poppy in E2

| Parent | $\begin{gathered} \text { P1 } \\ \text { (Banzatak) } \end{gathered}$ | $\begin{gathered} \text { P2 } \\ (\mathrm{DCG}) \\ \hline \end{gathered}$ | $\begin{gathered} \text { p3 } \\ \text { (Telia } \\ \hline \end{gathered}$ | $\begin{gathered} \text { P4 } \\ \text { (Iryianian) } 1.3 \text { ) } \\ \hline \end{gathered}$ | $\begin{gathered} \text { P6 } \\ \text { (up white) } \end{gathered}$ | $\begin{gathered} \text { P7 } \\ \text { (Hafenea) } \end{gathered}$ | (428 ${ }^{\text {Pa }}$ ania) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -11.29** | -0.03 | 0.150 | $-0.40^{* *} 0.25^{* *}$ | 0.35** | $-0.65=$ | -1.17* |
| Pz |  | $0.20{ }^{\circ}$ | -0.33** | - $0.18^{\circ=0} 0.56^{\circ 0}$ | -0.13 | 0.24** | 0.250 |
| P3 |  |  | 0.02 | $0.20^{\circ 0}-0.55^{\circ}$ | -0.2500 | $0.22=$ | 0.63** |
| P4 |  |  |  | $0.27 \times 0.20$ * | $0.70^{* *}$ | -10.23n= | 1.58** |
| pr |  |  |  | -0.09** | 0.45** | 1.42** | 0.13 |
| P6 |  |  |  |  | -0.29** | $0.52^{\circ}$ | 0.03 |
| 87 |  |  |  |  |  | 0.150 | $0.50{ }^{* *}$ |
| P8 |  |  |  |  |  |  | 0.04 |

- SIgnificant at 5/ laval
*nsigntpicant at $1 \%$ leval

| $S E(\hat{1})$ | $\pm 0.0227$ |
| :--- | :--- |
| $S E(9 \hat{i}-g \hat{J})$ | $\pm 0.0344$ |
| $S E(5 \hat{j})$ | $\pm 0.0696$ |

SE $(S \hat{j}-5 \hat{i} k)=0.7031$
$S E(5 \hat{i} j-5 \hat{j} k) \neq 0.0972$

## Table 30

Tea effects (diagonal) and ace effacte (opf diagonal) for number of atignatie rays/eapsule in $8 x \mathrm{~B}$ diallel of opiun poppy in E. 4

(Table 38) . Pa (0.29) was signipicantiy auperiar to other twa parents while P7 was superior to P6 . Comparesion of crassen with negative apfects showed that P5 ( -.04 ) recorded lowest gea apfact but was found to be at par with P4 and P2.

In pooled analysia, all parenta (four ulth poaitive affects) had significant gea offects (Table 39). Though p7 ( 0.19 ) did not differ significantily fram ps ( 0.17 ). it uns Pound to te significantly supariar to $P 2$ and $\mathrm{P}_{4}$, which wera at paz. Lowast signipigant and negativa gea effect was recordnd by p5 but it was found to be at par with 派 and P3.

## 4.3 .4 SLh EFFECT

In EZ, twanty Pour arosads (aixtann with positive apfecta) were Paund to pasassa aignificant sca epfacts (Table 37) . Lrasis $4 x k_{\text {, }}$ though did not differ significantly Pram $5 \times 7$, ans Paund to be signiplantiy superior to the remaining Groasase . Lowast, signsfigant and nogative sea epfect wan racordad by $2 \times 4$, but it eus faund to be at par with $4 \times 7$. $3 x 6$ and $2 \times 3$. In E4, twenty arasess (nine with ponitive afferts) had significant sca affents (Tabla 3a). Cfass 5x7 aan Pound to be aignifiannely superiar to rassining opasses having positive affacta, but wau found to be at par aith $2 \times \cos$. Lawast aignificant and negative
sca affeet was recordad by $1 \times 7$ trut it was Pound to bie at par with $5 x$ 石, $7 x$ and $2 x^{4}$.

In pooled analysis, excapt $3 x 6$, all aromans (Pifteon with positiva offacta) had signifigant sce effects (Table 39). Drosa $5 \times 7$ (1.07) uan Pound to be significantly superiar to remaining exassen. The next eroas in arder of merit quss $4 x 0(0.74)$. Thaugh, $4 x 7$ recozdend 2avent, aignificant and negativa aca effect, it was faund to lag at pas with efght othar arosses *
4.9 LATA. YILLDD

## 

The highest and lowest maan valuea vere recorded by parante P4 ( 0.274 gm ) and P1 ( 0.190 gm ) raupectively (Table 40). Among arossea higheat and lawat mean values were absurvied for $4 \times 5(0.446 \mathrm{gia})$ and $1 \times 7(0.201 \mathrm{ga})$ reopectivedy.
4.9 .2 HLTLGDSIS

A11 arossen exdapt $4 \times 7$ recerded aigniplaant heterasis with only thras having nagativa heterasin aver better parent (Tabla 41). HIghast pasitive heterosia was racopided by $4 x$ fallowed by $2 \times 5$.

Table 39
Sca affocts (diagonal) and sca affacts (off diagonal) for number of stigaatic rays/capsule In BxA diallel of opium pappy (Over environments)

| Farent | (Banzatak) | $\begin{gathered} \text { P2 } \\ (\text { DCL }) \end{gathered}$ | (Talia 1) | $\begin{gathered} \text { P4 } \\ \text { (Irianian) } \\ \text { (EL } 3 \text { ) } \\ \hline \end{gathered}$ | $\begin{gathered} \text { P6 } \\ \text { (up Unite) } \end{gathered}$ | $\begin{gathered} \text { p7 } \\ \text { (Hoffansa) } \end{gathered}$ | $\begin{gathered} \text { PH } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -0.26** | 0.20** | -0.21** | $-0.43 *=0.18^{*=}$ | $0.14=$ | $-0.430 *$ | 0.51 = |
| Pz |  | $0.06{ }^{*}$ | -0.43 ${ }^{\text {a }}$ | -0.25* $-0.10^{*}$ | 0.12 ** | -0.15** | $0.47{ }^{\text {\% }}$ |
| P3 |  |  | -0,1300 | 10.14** $\quad 0.21=0$ | 0.01 | 0.14** | 0.42 ** |
| F4 |  |  |  | $0.99{ }^{\text {a }} 0.27 * *$ | 0.390* | -0.08\% | 0.74 = |
| P5 |  |  |  | -0.06* | $0.13{ }^{\circ}$ | 1.07** | 0.39 - |
| P6 |  |  |  |  | $-0.08 *$ | 0.39** | 0.11 = |
| 97 |  |  |  |  |  | 0.19 w | -0.36** |
| 4 P |  |  |  |  |  |  | $0.17=$ |

-5ignipicant at 5/ileval
**5Ignifisent at 1 , level
$\begin{array}{ll}S E(\hat{g}) & \pm 0.0249 \\ 5 E(\hat{j}-\hat{g})) & \pm 0.0377 \\ 5 E(s \hat{j}) & \pm 0.0764\end{array}$
${ }^{5 E}(5 \hat{3}, j-5 \hat{2 k}) \pm 0.1130$
SE $(5 \hat{i} j-5 \hat{j k}) \approx 0.1066$

## Table 40

Per-an perforaance of parents and hybrids in ixts diallel of opium poppy for latex yield/plant (gm) (pooled analysie)

| Parant | p1 (Aanzataik) | $\begin{gathered} \mathrm{P} 2 \\ (\mathrm{OCF}) \end{gathered}$ | $\begin{gathered} \text { p3 } \\ \text { (Telía 1) } \end{gathered}$ | $\begin{gathered} \text { P4 } \\ \text { (IrEianian) } \\ \hline 155 \end{gathered}$ | (up PGite) | $\begin{gathered} \text { p7 } \\ \text { (HaPraea) } \end{gathered}$ | $\begin{gathered} \text { PB } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | 0.190 | 0.318 | 0.236 | $0.297 \quad 0.254$ | 0.260 | 0.201 | 0.229 |
| P2 |  | 0.221 | 0.235 | 0.3210 .360 | 0.338 | 0.278 | 0.267 |
| P3 |  |  | D. 272 | $0.411 \quad 0.360$ | 0.356 | 0.288 | 0.338 |
| P4 |  |  |  | 0.2740 .375 | 0.296 | 0.280 | 0.446 |
| PS |  |  |  | 0.222 | 0.270 | 0.275 | 0.293 |
| P6 |  |  |  |  | 0.233 | 0.281 | 0.202 |
| P7 |  |  |  |  |  | 0.234 | 0.287 |
| p8 |  |  |  |  |  | - | 0.253 |

Hate: Diagonal antrlas Por parantif opf diagonal ontrien far hybzids.

Table 41
Heterosid for oplum yield per plant（Pouled data）

## Hetarasis\％

Cresses
Quas bettar parant
OVur mid parant valus
$1 \times 2$
$1 \times 3$
$1 \times 4$
1×5
$1 \times 6$
1x7
$1 \times$ 目
$2 \times 3$
$2 \times 4$
$2 \times 5$
$2 \times 6$
$2 \times 7$
$2 \times 8$
$3 \times 4$
$3 \times 5$
$3 \times 6$
$3 \times 7$
$3 \times 8$
$4 \times 5$
$4 \times 6$
$4 \times 7$
$4 \times 8$
$5 \times 6$
$5 \times 7$
$5 \times 8$
$6 \times 7$
$6 \times 8$
$7 \times 8$

$54.74^{\circ}$ 粦
$23.81{ }^{*}$
20．02＊＊
$23.30^{\circ}$＊
$22.93^{\circ \circ}$
$5.190^{\circ}$
$3.390^{\circ}$
$15.62^{\circ}$
$29.70^{\circ}$ 。
62.53 ＂
$48.90^{\circ}$
22．20
12.66
$50.50^{*}$
$45.75^{\circ}$
40．99＊
$13.83^{\circ}$
28．76＂
51.21

16．77＊＊
$10.24^{* *}$
69．26＊＊
18．6日
20．610n
23.37
$20.34^{* *}$
$16.05^{\circ}$
17．86＊＊
＊SIgnificant at g\％Leval
＊＊Signipicant at $1 / 6$ ieval

## 4.9 .3 GCA CFFECTS

In E1, all parante had aignaficant gea urrueta (Table 42) . Fiva parents viz.o P4, P3, ${ }^{2} 8, ~ \mathrm{PS}$ and P 2 , secorded pasitive gea affecte . P4 was asignificantly suparior to the reanaining arosass. The ordar of sfonipioanca in athar parants was P3, P3, P5 and P2 . Lowest significant and negative ges offect uno ranozded by PG . In E 2 , all parents (faur with positive effacts) had significant gea effiets (Table 43). P4 was Pound ta be significantly superior to renaining orasses . Though pr did nat aiffer significantly fran py fur nagativa ga affact, it had louest negative affact. In 53, aix parante (four with puaitive effecta) recoriod aignsficant gea effecte (Table 44) . P4 was signifigantly auperioz tu pemaining crossas, naving poestive affocts . P1 racorded lounst. signiflagnt and nagative gea apfect. In E4, oix croanes (thren having poaitive effacta) had aignificant gea offect (Tabla 45) . H4 anas significantly auperior to athar arassas poseassing pasitive affecta, but it did not differ signiflauntly Pfon P3 . Lowest nagative effect was reaprded by P5 .

In poaled analyais, out of six aignipionnt parents Por gea offact thren parante vian, 04, 13 and PE had paeitive

Table 42
Lee effects (diagonal) and sca effecta (off diagonal) por latax yield per plant in exx diallel of oplum poppy in $\mathrm{E}, 1$

| Pazant | $\begin{gathered} \text { Pq } \\ \text { (Manzatak) } \end{gathered}$ | $\begin{gathered} \mathrm{P} 2 \\ (\mathrm{DCC}) \end{gathered}$ | $\begin{gathered} \text { P3 } \\ \text { (Telia 1) } \end{gathered}$ | $\begin{gathered} \text { PA } \\ \text { (Ircianian) } \end{gathered}$ | PL | $\begin{gathered} \text { P6 } \\ \text { (up thite) } \end{gathered}$ | $\begin{gathered} \text { P7 } \\ \text { (HaPenea) } \end{gathered}$ | $\begin{gathered} \text { PB } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -0.0523** | $0.1013^{\circ *}$ | -0.0094*** | - 0.0018 | -0.0365 | $0.0476^{\circ 9}$ | -0.0431-* | -0.0499** |
| P2 |  | $0.0046^{\circ *}$ | $0.0363^{\circ *}$ |  | $0.0486=0$ | $0.1117^{* *}$ | $0.0750^{* * *}$ | -0.037s** |
| P3 |  |  |  | $0.1002^{00}$ | -0.0441** | $0.0450^{\circ \pi}$ | -0.0207 ${ }^{\text {a }}$ | -0.0005 |
| P4 |  |  |  | $0.0541^{\circ *}$ | $0.0731=0$$0.0084^{* *}$ |  | -0.0353 ${ }^{\text {cos }}$ | - 0.2007** |
| P5 |  |  |  |  |  | -0.0199** | $0.0132^{* *}$ | * 0.0844** |
| ${ }^{6} 6$ |  |  |  |  |  | $-0.0257=$ |  | - $0.0725^{\circ *}$ |
| 87 |  |  |  |  |  |  |  | - $0.0 .0262^{\circ 0}$ |
| Pe |  |  |  |  |  |  |  | $0.0158^{\circ 0}$ |
| * Sign | ificant at | 5\% Levol |  |  |  | $5 E_{(S \hat{i}}$ | Sink) | $0.0042426$ |
| ${ }^{*} 519$ | ipleant at | 1\%. lavel | ${ }_{55}$ (g $\hat{i}$ | $(-\hat{g} \mathrm{~s}) \geq 0.0$ | $0014142$ | $\left.S E(5)^{\prime}\right)$ | sik) | . 0040000 |
|  |  |  |  | $\text { ij) } \pm 0.1$ |  |  |  |  |

Lea effacts (diaganal) and sce affacts fopf diaganal) far 2etex yiald par plant in Bxi diallel uf apium puppy in E2


Table 44
Gee effects (diagonal) and eca effects (off diagonal) for latex yield per plant in BxB diallel of aplum poppy in E. 3


## Tabla 4

Ges effucta (diagonal) and sea apfocts (app diagunai) for latex yiold per plant in Bxa diallal of oplum poppy in E4

| Parent | $\begin{gathered} \text { P1 } \\ \text { (fanzatak) } \end{gathered}$ | $\begin{gathered} \mathrm{P2} \\ (\mathrm{DCE}) \end{gathered}$ | $\text { p3 }_{\text {(Telia } 1 \text { ) }}^{\text {p3 }}$ | $\begin{gathered} 94 \\ (1 \text { rrianian) } \end{gathered}$ | $\left(\mathrm{LL}^{\mathrm{PS}} 3\right)$ | (up Whi | (ts) (Hapeme | a) (Galania) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -0.0224 ${ }^{\circ}$ | 0.054700 | 0.0074 | 0,0020 | ロ.0391** | 0.0 | 0.0029 | -1.0210** |
| 12 |  | -0.0038 | 日.0128* | $-0.0344{ }^{\circ *}$ | Q.0775** | $0.0134^{*}$ | -0.0317** | -4.0306** |
| p3 |  |  | $0.0145 *$ | 9.03aree | $0.0402 * *$ | $0.10751{ }^{\circ} \mathrm{*}$ | $0.0620^{\circ 0}$ | U.0241** |
| P4 |  |  |  | 0.0189e* | 0.0198 | $0.0607^{* *}$ | D.0176** | $0.8317^{\circ}$ a |
| P5 |  |  |  |  | -0.0072** | -0.0222** | - D.0363** | 0.0036 |
| P6 |  |  |  |  |  | 0.0029 | - $0.0184^{* *}$ | 0.059800 |
| P7 |  |  |  |  |  |  | -8.014000 | $0.0606 * *$ |
| PR |  |  |  |  |  |  |  | $0.0109 \times 0$ |

- Significant at F Inval
* Signipicant at $1 \%$ lavol
$\begin{array}{ll}3 E(\hat{g i}) & \pm 0.029940 \\ 3 E(\hat{i}-g \hat{j}) & \pm 0.002933 \\ 3 E(\hat{\mathrm{ij}}) & \pm 0.005946\end{array}$
effects (Table 46) - P4 (.0366) was aignificantly superioz to $P 3$ (.0260) and $P 0$ (.0040) . P3 was significantly superior to PB . Slgnificantly lower negative gea effoct was recnedud by P6 ( -.0059 ) -


### 4.9.4 SCh E.FRLCTS

611 erosaes recordad significant asa apracts in
L. 1 (Table 42). Thiste日n crosses wese observed to have aignificant and paritive sca affoct . Dut of thoan, $4 \times 6$ was found to be significantly supertor to remaining crowans axcept erons $2 \times 6$, with winich it was at par . Khough $5 \times 6$ did not differ from $5 \times 7$, it had recordad lowet negative sca affect. In E2, all arosaes had signlficent sea affecta (Table 43). Thirteun craases had panitive offacta. Crosen $1 \times 3$ recordad highast and positive aes offoot and was found to be aignificantly superior tel ramaining eroanem . It was Pollawed by $4 x 3,5 \times 7$ and $2 \times 6$ in order of aignipiatance . Though 7xil was Pound to ba at par with $2 x e_{0}$ it recorded Iowast, glgnificant and negativa effecta. In 53, twanty orosaes (aixtean with positiva afPacta) had aignificant sea afPacta (Table 44). Crase $2 \times 5$ was abuorvad to bo Bignifleantly auperior to ramalning erosses having pusitive uffaets. Crasa 3x6, though did not differ from $1 \times 2$, was significantly superier to romsining thictean crosases, with positive affucte . Lovgat, aignificant and negative sea

Table 46
Cea effects (diagonal) and aca affacte (apf diagonal) for latex yiald par plant in ext diallel of opiun poppy (Divar enviramenta)

| Farant | (Ranzatak) | $\begin{aligned} & \text { P2 } \\ & \text { (DCG) } \end{aligned}$ | $\mathrm{Cl}_{\text {P3 }}^{\text {Tsia 1) }}$ | (Irrianden) | $\stackrel{\text { ps }}{(L L 3)}$ | (up Whits) | $\begin{gathered} \text { P7 } \\ \text { (HePemas) } \end{gathered}$ | $\stackrel{\mathrm{pa}}{\text { (Gaiania) }}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -0.036300 | $0.0666^{* *}$ | 0.0007* | $0.0097 *$ | 9.0 | $0.0146 *$ | -0.02530* | -0.0263** |
| P2 |  | 0.0009 | -0.0307** | -0.0053 | 0. $06800^{*}$ | $0.0542^{64}$ | $0.0133^{\circ \circ}$ | -0.0267** |
| P3 |  |  | D.026044 | $0.0588{ }^{\text {- }}$ | 0.0421=7 | D.0463** | -0.0026 | 0.0184** |
| P4 |  |  |  | $0.0356 \% *$ | 0.0465\% | -0.0243 ${ }^{\circ}$ | -0.0212 ${ }^{\text {e* }}$ | $0.0116^{* *}$ |
| PS |  |  |  |  | 0.0023 | -0.0160 ${ }^{4}$ | $0.001^{\circ}$ | -0.0029 |
| ${ }^{16}$ |  |  |  |  |  | -1.0059** | $0.0223^{\circ}$ | -0.0057 |
| P7 |  |  |  |  |  |  | -0.0250** | $0.0184^{* *}$ |
| P6 |  |  |  |  |  |  |  | $0.0040^{\circ 0}$ |
| - 5ignificant at 5s lavel ** Significant at $1 \%$ ievel |  |  |  | $S E(\hat{g})$ $\pm 0.001289$ <br> $S E$  <br> $S E(\hat{1} \hat{i}-\hat{j} \mathrm{j})$ $\pm 0.001949$ <br> $5(5 \hat{f})$ $\pm 0.003952$ |  |  | -5ik) | $\pm 0.005848$ |
|  |  |  |  |  | 1]-5́k) | $\pm 0.005514$ |
|  |  |  |  |  |  |  |

effoct vas obeervad for $1 \times 3$, thaugh it did not differ prou 546 and $2 x 0$. In E.4, tuenty thrau arasess had significant soa effacta (Table 45) . liut of sixtaen erasaea possasaing gignificant and positivn effocts, erase $2 \times 5$ was aignificantly superiog to runsing croases excapt $3 \times 6$ and $3 \times 7$, with whome, It tuda Pound to be at par. The lowest negative effegt wos recordad by $6 \times 7$ but it uas Pound to ba at par with Pive othaz crossall .

In paaled analysis, toanty threo aruases had aignificant ace affacts (Table 46). Dut of sixtaun crasses having positive and significant affect, $2 x$ (.06B0) vas signiflaantly auparior ta ramang argasan, but vaif faund tu be at per with $1 \times 2$ (.0666) and $3 \times 4$ (.0583) . Lowart, aignificant and nagative sea offact sas racordad by $5 x b$ ( -.0160 ), but it was found to be at par with PIve athar ecrobses -

### 4.10 BECD YILLD

## 

PS ( 7.28 gm ) had highest mean valua far aven y fald par plant Pollowed by, P7 (7.18 gas), P2 (7.10 ga) and the 1 dowst value of 6.22 gen van abserved far pi (Table 47). ilighest and ldweat muan values of seed yield in eromema were cocordad by $4 \times 6(10.54 \mathrm{ga})$ and $2 \times \mathrm{k}(5.50 \mathrm{gm})$

## Tabla 47

Poz se Parfarmiance of paranta and hyscide in axp diallel of opium poppy far saed yield/ plent (gn) in pooled analysis


Hotat- DLagonal entrian Por paranta; UPR diagonal ankziea Far hybriden

### 4.10 .2 HETCRLS 15

Waly thirten crasaas recorded signipicant heterosis over bntter pacent and out of these oight crosses had pasitive hetorasis (Table 4a) - Crosa $4 x 6$ recorded highast aignifioant and positive haterasia quer better parant -

### 4.10.3 GCA L.FFLCTS

In E1 only P2 (Positive apfact) and P8 (nogetive apfoct) had significant gea spfacta (Table 49). In E2, Pive parentes recardad significant gen efPacta (Tuble 50). Threu parenta vize, P4, 95 and P6 had aignifiannt and pusitive gea apfocts but all wera found to be at par. Theris wan no signiflcant diffarance prawnt bebwan twa parants having aignificant and nagative gea offacta. In E3, Pivi paranta (thres aith poaitiva uffacts) had significant uca effects (Tabin 51). Thera axfisted no aigniflcant dipfarancua amang enrex parents vizev P6, P2 and 151 having pastive gea offact. PB was significantiy infarior ta p\% for negativa gea ePFeats. In L4, andy P5 (whth pasitivg affact) nral 1 'R (with nagativie offact) had aignificant gea arfactis (Tabla 52).

In poolad anolyais, Pive pavents had aignifieant

Tabla 48
Heterosis Por saed yisid per plant in poulud tiate

## Haterasish

Crasses Ovar better parant Duar mid garent value

|  | 5.15 | 12.69* |
| :---: | :---: | :---: |
| $1 \times 2$ | -6.03 | - 11.76 |
| $1 \times 3$ | -5.67 | - 0.30 |
| $1 \times 4$ | -11.13* | - 4.15 |
| $1 \times 5$ | 30.78** | 36.51 .0 |
| 1×6 | -12.81* | - 6.57 |
| $1 \times 7$ | -1.59 | - 3.68 |
| $1 \times 8$ | -12.12 | -10.75 |
| $2 \times 3$ | -12.13 | 6.04 |
| 2x4 | $11.54{ }^{*}$ | $12.31 \%$ |
| $2 \times 5$ | 1.14 | 2.93 |
| 2×6 | - 0.56 | - 0.56 |
| 2x7 | - $23.40^{\text {a }}$ | -22.92 ${ }^{\text {E }}$ |
| $2 \times 8$ | -2.5.38 | - 4.71 |
| $3 \times 4$ | 1.65 | 3.93 |
| $3 \times 5$ | $23.12^{\text {\% }}$ | $24.65{ }^{\circ}$ |
| $3 \times 6$ | 23.94 | $9.62^{*}$ |
| $3 \times 7$ | 7.94 | 3.06 |
| $3 \times 6$ | $27.75^{\circ} \mathrm{d}$ | 29.71** |
| $4 \times 5$ | $49.29{ }^{\text {2 }}$ | $52.20{ }^{* *}$ |
| $4 \times 6$ | -49.21 | - 0.98 |
| $4 \times 7$ | - 0.42 | - 0.6 .64 |
| $4 \times 8$ | - 0.32 | - 2.63 |
| $5 \times 6$ | -11.54* | 12.31* |
| $5 \times 7$ | $14.97{ }^{*}$ | 16.49** |
| $5 \times 3$ | $12.67{ }^{\circ}$ | 15.82** |
| $6 \times 7$ | -12.41* | -10.520 |
| $6 \times 9$ | -12.91 | - 0.34 |
| $7 \times 8$ |  |  |

* Significant at 5/a Level
** Significant at 1 level


## Table 49

Gee effects (diagonal) and sca apfects (off diaganal) for saad yield per plant in axe diallel of opium poppy in E. 1


[^6]| $\operatorname{SE}(\hat{g i})$ | $\pm 0.1647$ |
| :---: | :---: |
| $\operatorname{SE}(\hat{g i}-\hat{g} \hat{j})$ | $\pm 0.2490$ |
| $\operatorname{si}_{(5 i j)}$ | $\pm 0.2549$ |

$S E(5 \hat{j}-5 \hat{S i k}) \pm 0.7470$
SE(5ij-Sik) $\pm 0.7043$

Tabla 50
Gce effects (diagonal) and sea affects (off diagonal) Por seed yield per plant in Ex8 diallel of opium poppy in E2

| Pazant | $\begin{array}{ccc} \text { P1 } & \text { P2 } & \text { P3 } \\ \text { (Ranzatak) } & \text { (OCE) } & \text { (Talia 1) } \end{array}$ | $\begin{gathered} \text { P4 P5 } \\ \text { (Irrianian)(LL3) (UP } \end{gathered}$ | $\begin{aligned} & \text { P6 } \\ & \text { White })(H 1 \end{aligned}$ | $\begin{aligned} & \text { P7 } \\ & \text { Iafimea) }\left(L_{8}\right. \end{aligned}$ | $\begin{aligned} & \text { PG } \\ & \text { alania) } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | $-1.049000 .049-0.696$ | $0.041 \quad-0.031$ | 0.351 | $-1.352^{\prime \prime}$ | -1.168 |
| P2 | $-0.888^{* *}-1.157$ | -0.602 -1.632* | -1.440* | -0.113 | -1.669 |
| P3 | $=0.143$ | $-2.477 * 0.0$ | 0.985 | 1.482* | 0.786 |
| P4 |  | Q.532* 0.848 | 4.187000 | -0.863 | -0.349 |
| P5 |  | $0.862^{* *}$ | $-1.960^{* *}$ | $0.337$ | $3.321=0$ |
| P6 |  |  | $0.740^{* 4}$ | 1.699** | -2.127** |
| p7 |  |  |  | 0.343 | -0.600 |
| P右 |  |  |  |  | $=0.401$ |

* Signipicant at 5\% level
**Significant at $1 \%$ lavel
$\begin{array}{ll}S E(\hat{g}) & \pm 0.2174 \\ S E(\hat{i}-\underline{g j}) & \pm 0.3286 \\ S E(5 \hat{j}) & \pm 0.6663\end{array}$
$\mathrm{SE}_{\text {(Sij-5ik) }} \pm 0.9859$
SE. $(5 \hat{i} j-9 \hat{1} k) \pm 0.9295$

Table 51
Gea effecte (dlaganal) and sca effacta(opf diaganal) for sasd yield per plant In oxe diallel of opium poppy in E3

| Parent | (Ranzatak) | $\begin{gathered} \text { P2 } \\ (\mathrm{DCG}) \end{gathered}$ | $\begin{gathered} \text { p3 } \\ \text { (Tolia 1) } \end{gathered}$ | $\begin{gathered} \text { PA } \\ \text { (Irrianian) } \end{gathered}$ | $\begin{gathered} \text { p5 } \\ (\mathrm{LL.} 3) \end{gathered}$ | P6 Up Shita) | (Hapama) | $\begin{aligned} & \text { Pa } \\ & \text { Galania) } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | 0.369** | $0.816^{*}$ | $0.926^{\circ}$ | -0.173 | -0.674 | $1.654^{\circ}=$ | $1.320^{\circ 0}$ | $1.577^{\circ *}$ |
| P2 |  | $0.395 *$ | - $0.9 .94 \mathrm{D}^{\circ}$ | $1.941^{\circ 0}$ | 3.690** | 0.668 | -0.156 | -8.789 |
| P3 |  |  | -0.185 | -0.889* | -0.290 | 0.178 | 0.684 | -0.399 |
| P4 |  |  |  | 0.234 | 1.051* | 0.479 | 0.325 | 0.672 |
| P5 |  |  |  |  | 0.105 | -1.022" | -1.256** | -0.529 |
| 86 |  |  |  |  |  | 8.347* | -0.658 | 0.059 |
| P7 |  |  |  |  |  |  | -0.849** | 0.035. |
| P0 |  |  |  |  |  |  |  | -0.416** |
| * Significant at 5\% lavel <br> **significant at win level |  |  |  | $\begin{aligned} & S E_{(\hat{g i})} \\ & S E_{(\hat{i n}-\hat{j})} \\ & 5 E_{(\mathrm{sij})} \end{aligned}$ | $\text { j) } \begin{aligned} & \pm 0.1356 \\ & \pm 0.2049 \\ & \pm 0.4155 \end{aligned}$ |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |

Tabls 52
Gea affacts (diagonal) and scea effecta (opp diagonal) for soed yield par plant in Bxe diallal of opium poppy in EA

gea sppecte (Teble 53). Threu parants vize. P6 (0.464), p5 ( 0.392 ) and p4 ( 0.338 ) had pasitive and signifiuant affacts but all wern at par . Na aignificant differenca exsistod between the two parants having natyative gea epfects.

### 4.10.4 sich EFFLCTS

In E1, twenty ane eroseses had aignificant sca apfects (Table 49). Twalva crossess had pasitive and signipicant affucts - Cross $1 \times 6$, thaugh did not differ aignspicantly Prom $4 \times 5$ and $1 \times 2$, was gbserved to be signipicantly superior tu romaining aroasses having positsve apfacta. Ha significant differences werra found to axaist anang ergoaes having nagativa aca affocts . In E2, only ten crosses had signifleant sea affanto (Tabla 50). unly thron ergases viz., $4 \times 6,6 \times 7$ and $3 \times 7$ had signipieantly and poaltive gal effacts . Grasa $4 \times 6$ was significantly superior to other erosege . All erasess having negative and algnificant sea offects wero at par. In E3, out of twalva significant sca affact crosses, aight had panitivu offuct (Table 51) . Crama $2 \times 5$ was found to be aignificantly suparior ta ather esossen passassing poaitivin offucta . A.1. erasges having negative and aignifleant acd affocts were at par. In E4, out of savantaen algnificant sa effact agueses, anly aix had pusitive affect (Tubla 52). Croma $4 \times 6$ mas algnificantly auperior ta athar erosees

Tabla 53
Gea effecte (diagonal) and aca offacts (apf diaganal) Par sand yiald par plant in Bxi diallel of opiun poppy (Dvar anvirunaents)

| Parant | (Ranzatak) | $\begin{gathered} \text { P2 } \\ \text { (DCG) } \end{gathered}$ | $\begin{gathered} \text { p3 } \\ \text { (Telia 1) } \end{gathered}$ | $\begin{gathered} \text { PA } \\ \text { (Irrianian) } \end{gathered}$ | $\left(\begin{array}{c} \text { P5 } \\ (L S) \end{array}\right.$ | up White) | $\begin{gathered} \text { P7 } \\ \text { (Hapsama) } \end{gathered}$ | $\begin{aligned} & \text { P日 } \\ & \text { (Galania) } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Pq | -0.442** | 0.886 | -0.193 | -0.534 | -0.778 | $1.560^{\circ} \%$ | -0.563 | -0.039 |
| P2 |  | -0.192 | -0.673 | 0.106 | 0.622 | -0.380 | 0.067 | -1.199** |
| P3 |  |  | -0.123 | -10.833 | -0.167 | $0.931{ }^{\circ}$ | 0.608 | 0.472 |
| P4 |  |  |  | $0.398^{\circ}$ | $1.272^{\circ *}$ | 2.440 ${ }^{\circ 6}$ | -0.553 | -0. 109 |
| P5 |  |  |  |  | 0.392** | -0.934* | 0.463 | 1.057** |
| P6 |  |  |  |  |  | $0.464{ }^{\text {e* }}$ | 0.361 | -1.145** |
| P7 |  |  |  |  |  |  | -0.033 | -0.318 |
| PB |  |  |  |  |  |  |  | -0.407** |

* 5ignifieant at $\%$ iavol
** Significant at $1 \%$ level

$$
\begin{array}{lll}
\text { SE. }(\hat{g}) & \pm 0.1415 \\
3 E_{( }(\hat{g} i-\hat{g} j) & \pm 0.2140 \\
S E \\
(5 \hat{i} j) & \pm 0.4338
\end{array}
$$

| $S E(S \hat{j} j-S \hat{S} k)$ | $\pm 0.6419$ |
| :--- | :--- |
| $S E(S \hat{i} j-\hat{S j k})$ | $\pm 0.6052$ |

possessing poaitive spfacts. Lowast, signifleant and negative aca epfent was observed for $2 \times 5$, but it was Pourid ta ba at par with nina othar crassees.

In pouled analysis, nina erossae had bignificant sco effacte (Table 53) . $3 i x$ erasses Vizo, $4 \times f, 1 \times 6,4 \times 5$, $5 \times 8,1 \times 2$ and $3 \times 5$ had pasiedve and aignificene sea spfect . Crons $4 \times 6$ though did nut diffor aignipicantiy Pran $1 \times 6$ and $4 \times 5$, was found ta be bignificantiy suparior to remaining orussas. Thers axfistad nu significant diffaruncos agang eresses having aigntficant and nogative aca affacta .

## 4. 11 HESK YILLO

### 4.11.1 Per se PERI ORINNCE.

 and was follawad by $94(5.43 \mathrm{gm}), ~ \mu 2(5.40 \mathrm{gm})$ ans $\mathrm{P} 5(5.34 \mathrm{gm})$. The lewest mean value wan ghaerved for Pi ( 4.32 gia). Aasng crosses highest and lownst man values ware ohsaryad for $4 \times 6(0.06 \mathrm{gm})$ and $1 \mathrm{k7}(.4 .44 \mathrm{gm})$ respeatively (Tabla 54) .
4.11.2 HETEROASS

Fourtnan crassea had aigniplcant hutarasie over bettar perant and out af thase only Pive recorded pasitive

Table 54
 in pooled enalyais

| Parant | $\begin{gathered} \text { PI } \\ \text { (Ranzatak) } \end{gathered}$ | $\begin{aligned} & \mathrm{P} 2 \\ & \text { (DCE) } \end{aligned}$ | $\begin{gathered} \text { P3 } \\ (\mathrm{Talfa} \end{gathered}$ | 1) (Irrianian)(LL3) | (up Whita) | $\begin{gathered} \text { P? } \\ \text { (Hapmm } \end{gathered}$ | $\begin{aligned} & \text { Pa } \\ & \text { Galania) } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | 4.32 | 5.31 | 5.01 | 4.95 4.33 | 5.90 | 4.44 | 4.49 |
| P2 |  | 5.40 | 4.55 | 5.43 5.30 | 5.33 | 5.13 | 3.85 |
| P3 |  |  | 4.97 | 4.97 5.68 | 5.91 | 5.95 | 5.52 |
| P4 |  |  |  | $5.43 \quad 7.20$ | B.06 | 5.31 | 5.80 |
| P5 |  |  |  | 5.34 | $5.39$ | 6.58 | 7.37 |
| P6 |  |  |  |  | 4.84 | 6.37 | 5.00 |
| P7 |  |  |  |  |  | 6.30 | 5.18 |
| P8 |  |  |  |  |  |  | 5.08 |

Hotes- Dfagonal entrias Por parentag Ogf diagunal antried Par hybrids.
hetarosis (Tabia 55). Higheat pasitive heterasis avar better parent was abserven for $4 \times 6$ Pallaved by $5 \times 6,4 \times 5$, $1 \times 6$ and $3 \times 6$.

### 4.11.3 GLA EFFLCTS

In E. 1 bxcopt for p3 all othos parant had aignlpicant goa offocts and out of thase only theae vize, D2, P6 and P7 had pasitive uffacta (Tablu 56). P2, though did nat differs. Bignificantiy Ptan P6, was olaenrved to ba significantly Bupesiar to $P 7$. Lowest, aignipicent and nagative ges uppect was ragardsd by p4, though it was found to las at par with Pa and P5. In E.2, six paranta had significant gea uffect (Table 57) - Fqur parianta vizen $155, ~ P 4, ~ P 7$ and $P G$, had pasitive uppact and wires pound to be at par. For nagativa gen affect P自 was signifiaantly infierior tu ipl. In [.3. oniy Pour parents had signiflcant gea uffoets (Table 58). p4 and p2 hod posltive nffact and were Pound to be at par . P7 and pa had nagative affact and no aignifleant differmes sxalatad between thea. In E4, sxespt pll s all parants had algnificant gea offect (Table 59). Four parants ( $\rho 5$, p7, [A and P6) racorded positiva appact and ware found ts bo at pas - Lament, nignifleant and nagative gea apract was rucarded by P3.

In poolad analysia, Bix parants (Pour with nositiva) hat significant gea offecta (Tabie 6a). Pa,

Table 55
Hateronia Por husik yield pur plant (Pooled data)

| Crosesa | Hatarosg\% |  |
| :---: | :---: | :---: |
|  | r better | Var mid parant value |
| 1x2 | - 1.67 | $9.26{ }^{\circ}$ |
| $1 \times 3$ | 0.80 | 7.36 |
| $1 \times 4$ | - $\mathrm{F} .84^{\circ}$ | 1.34 |
| 1×5 | -16.9100 | -10.35* |
| $1 \times 6$ | 21.9000 | 20.823** |
| $1 \times 7$ | -29.52 ${ }^{\text {a }}$ | $-16.38{ }^{* *}$ |
| 1×8 | -11.61* | - 4.47 |
| $2 \times 3$ | -15.74** | -12.25** |
| $2 \times 4$ | 0 | 0.28 |
| $2 \times 5$ | - 1.35 | - 1.30 |
| $2 \times 6$ | -1.30 | - 4.10 |
| $2 \times 7$ | -18.57** | -12.30** |
| 2x8 | -28.70** | -26.5300 |
| $3 \times 4$ | - 8.47 | - 4.42 |
| $3 \times 5$ | 6.37 | $10.16^{\circ}$ |
| $3 \times 6$ | 18.91** | $20.45{ }^{\circ}$ |
| $3 \times 7$ | - 5.56 | 5.59 |
| $3 \times 8$ | 6.66 | 9.65* |
| $4 \times 5$ $4 \times 6$ | $32.60{ }^{\text {ec }}$ | $33.79^{* *}$ 56.960 |
| $4 \times 6$ $4 \times 7$ | - 45.43 .71 " | $56.96^{\circ}$ $-9.46{ }^{\circ}$ |
| 4 xB | 6.01 | 10.37** |
| $5 \times 6$ | 0.94 | 5.69 |
| $5 \times 7$ | 4.44 | 13.06 " |
| $5 \times 8$ | 30,01" | $41.46^{\circ 0}$ |
| $6 \times 7$ $6 \times 8$ | 1.11 -1.57 | $14.360 \%$ 0.81 |
| -7x8 | $-11.70^{\circ}$ | -8.96* |

- Signipigant at 5\% level
* Significant at 1 俭 level

Tabla 56
Gea effects (diagonal) and aca apfacta (off diaganal) par huald yiald par plant in Bx8 diallel of oplum poppy in ET


- Signipicant at 5\% lavel
e* Significant at $1 \%$ level

SE (gh) 40.0537
SE $(g \hat{i}-g \hat{j}) \neq 0.0012$
SE $(g \hat{\jmath j}) \quad 0.1647$
$5 E(S \hat{j}-5 \hat{i k}) \geq 0.2437$
$\mathrm{SE}_{(\mathrm{Sij}-\hat{\mathrm{Sik}})}^{(\mathrm{Nij}} \pm 0.2298$

Tabla 57
lice offacts (diagonal) and sea affects (off diaganal) Por husk yield per plant in axil diallel of oplum poppy in E2


Tabla 58
Gea effocts (diagonal) and sca offacts (apf diaganal) for husk yiald per plant in Bx8 diallal of opium poppy in E3

| Parent | $\begin{gathered} \text { P1 } \\ \text { (Ranzatak) } \end{gathered}$ | $\begin{gathered} \rho 2 \\ \text { (DCG) } \end{gathered}$ | $\begin{gathered} \text { P3 } \\ \text { (Tella } 1 \text { ) } \end{gathered}$ | $\begin{gathered} \text { P4 } \\ \text { (Irrianjan) } \end{gathered}$ | $\begin{aligned} & \text { P5 } \\ & \text { (Li.3) } \end{aligned}$ | $\begin{gathered} \text { P6 } \\ \text { (up White) } \end{gathered}$ | $\begin{gathered} \text { p7 } \\ \text { (HaPgena) } \end{gathered}$ | $\begin{gathered} \text { P8 } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | 0.092 | 8.782** | 0.859** | 0.260 | -0.521** | 1.466\% | -8. 128 | $0.794^{* *}$ |
| P2 |  | $0.184^{\circ}$ | -0.153 | 1.559** | 1.989** | -0.736 ${ }^{60}$ | 0.200 | -0.4.48 |
| P3 |  |  | -0.103 | -0.905** | -0.106 | 0.121 | -0.653* | 0.249 |
| P4 |  |  |  | $0.376^{\circ}$ | $0.665{ }^{\circ}$ | $0.822{ }^{\text {*** }}$ | -0.212 | $0.740^{\circ 0}$ |
| P5 |  |  |  |  | 0.117 | -0. 299 | -0.203 | 0.209 |
| P6 |  |  |  |  |  | -0.150 | -0.026 | -0.004 |
| P7 |  |  |  |  |  |  | $-0.336^{\circ 8}$ | -2002 |
| PR |  |  |  |  |  |  |  | -0.178* |

* Signiricant at $5 \%$ leval
** Significant at 1 lavel

$$
\begin{aligned}
& S E(g i) \pm 0.0887 \\
& S E_{(g i-g j)} \div 0.1342 \\
& 5 E_{(S i j)} \quad 0.2720
\end{aligned}
$$

SE (Sij,j-Sik) $\pm 0.4025$
$S E($ Siju-SÎk) $\pm 0.3795$

## Tabla 59

Hea effoots (disgonal) and sca offacts (off diaganal) for husk yield por plant in Bx日 diellel of opium poppy in E4

| Parant | $\begin{gathered} \text { Pq } \\ \text { (Ranzatak) } \end{gathered}$ | $\begin{gathered} \mathrm{P2} \\ (\mathrm{DCE}) \end{gathered}$ | $\begin{gathered} \text { P3 } \\ \text { (Telia 1) } \end{gathered}$ | $\begin{gathered} \text { P4 } \\ \text { (Irrianian) } \end{gathered}$ | $\begin{gathered} \text { P5 } \\ (\mathrm{LL.} 3) \end{gathered}$ | $\begin{gathered} \text { P6 } \\ \text { (up Mhite) } \end{gathered}$ | $\begin{gathered} \text { P7 } \\ \text { (Haptaea) } \end{gathered}$ | $\begin{gathered} \text { PQ } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -0.587** | 0.220 | 0.020 | -0.240 | -0.590 | 0.360 | -0.410 | -0.650 |
| P2 |  | -1.027 ${ }^{\text {en }}$ | -0.370 | - 6.430 | -D.650 ${ }^{\circ}$ | -0.500 | -0.603* | -0.7日0** |
| P3 |  |  | -0.227** | -1.003 ${ }^{\text {\% }}$ | -0.194 | 0.502 | 0.82' ${ }^{\text {- }}$ - | $0.620^{*}$ |
| P4 |  |  |  | 0.336** | Q. 413 | 2.999** | -1.766** | -0.743** |
| P5 |  |  |  |  | $0.557^{\circ}$ | -0.712** | 0.712** | $1.506 \%$ |
| P6 |  |  |  |  |  | $0.331 * *$ | 1.699** | -0.808** |
| P. 7 |  |  |  |  |  |  | $0.506^{*}$ | -0.443 |
| P8 |  |  |  |  |  |  |  | 0.113 |

[^7]SE $(\hat{g i}) \quad 0.0862$
SE $_{(\hat{i}-g \hat{j})} \pm 0.1304$
SE $_{(\mathrm{Sij})} \pm 4.2644$
\[

$$
\begin{aligned}
& S E_{(S \hat{L j}-S \hat{i k})} \pm 0.3912 \\
& S E_{(S \hat{j}-S \hat{I K})} \quad \stackrel{0}{2} .3688
\end{aligned}
$$
\]

Table 60
Gea effecta (diagonal) and sea epfacts (opf diagonal) Por huak yield per plant in $8 x 8$ diallel. of oplum poppy (Over enviranmants)


P5, P6 and P7 passessad pasitiva affact and werk found to be 㫙par. Fac parenta having nagetiva gea uffact pz was InPerior to P1.

### 4.11 .4 SCA EFFECTS

In E1, ninatasn arosase hed (alevait elth pasitiva aPPecta) signifieant nea nfPaeta (Tabia 56). Kraba Sx日 was signifioantily supsriag to tha rumaining tan eroasus passemaing positiva sffant. Lawaty signt clant and nergativa aca affact wad secardad by $2 \times 3$. In C2z uixtern exasses had significant sca uffacts (Tabls 57). Javan crasees had pasitive and significant sed affact and amant them crasa $4 x a ́$ waa significantly auperiar to ramaintng GFaBBea - Crami ixe racarded significantly luwase nagativa sca nfract but was found to be at par with aevan athar crosses - In E:3, ninu arasams recorded poaltivo and paur recarded negative signiplcant uce opferta (Tabla 5a). Thaugh there ware nu signipicant differances antuan $2 \times 5$, 2x4 and $7 \times 6$, the erais $2 \times 5$ was faund to ba algnifigantiy suparios ta remaining gradsea, passeasing posisive saa iffaet. A11 erasaeat having nagoliva effanka unta at par . In E4, gut of sixtean erossas aignificant Por aca apfoct, andy sixi had positiva sffeats (Table 59). Abang aroatas having pasitive afreat, erose $4 \times 6$ wan found to bu algnificantly supariar ta the ramalning arasant . Lovant,
aignificant and negative aca valum mas absarvad par $7 \times 5$ but 15 was Pound to bo at par ifith bight uthige eraasers.

In poolad analysia, qut of thirtoan erosesa having algnipicant sca affert, only six had poaitive effact (Table 6a) . The erass $4 \times 6$ (1.99日) Ehough did not uffar significantly fron $5 \times 8$, was olsampad ta be gignifieantly superios to the romaining oroseas having pasitive affouts . Un aignificant differsances wara presunt amang aaven crosses having nagative sca affects.

### 4.12 nursber of LFFECTIVE Lshicinge

Humber of affective lamaing if a new character Introducad in tha prasant invastigetion in opium poppy. More number of af Partiva lancinga fa deateabla charantar in opiun poppy *

### 4.12 .1 Pes on PCFFDAMAKCL.

Highast and lowast mean values In pasents sere observed for $\rho 7(4.96)$ and Paz 保 (4.01) raspactivady (Tabla 61). Among erosess highest and juwat samen values wera gbaurved for $2 \times 5(6.60)$ and Por $1 \times 5(4.26)$ reapaetivaly.

Table 61
Per se performence of parants and hybrids in $8 \times 8$ diallal of opium poppy for number of apfective lanelng/capsula in poelnd analyais

| Parent | $\begin{gathered} \text { P1 } \\ \text { (Ranzatak) } \end{gathered}$ | $\begin{gathered} \text { PZ } \\ (\mathrm{DCG}) \end{gathered}$ | $\begin{gathered} \text { P3 } \\ (\operatorname{Talla} 8) \end{gathered}$ | $\begin{gathered} \text { P4 } \\ \text { (Irsianian) } \end{gathered}$ | $\left(\begin{array}{c} \text { PL } \\ (\mathrm{Li} \\ \hline \end{array}\right.$ | (up Whata) | $\begin{aligned} & \text { P? } \\ & \text { (Haffanea) } \end{aligned}$ | $\begin{gathered} \mathrm{Pg} \\ \text { (Galanla) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | 4.52 | 5.25 | 4.26 | 4.39 | 4.79 | 5.89 | 4.64 | 5.09 |
| P2 |  | 4.48 | 4.44 | 5.22 | 6.60 | 5.66 | 5.24 | 4.99 |
| P3 |  |  | 4.58 | 5.39 | 4.88 | 5.02 | 4.56 | 4.35 |
| P4 |  |  |  | 4.75 | 5.06 | 4.96 | 5.48 | 5.08 |
| P5 |  |  |  |  | 4.34 | 4.32 | 5.01 | 6.15 |
| P6 |  |  |  |  |  | 4.12 | 4.44 | 4.83 |
| P7 |  |  |  |  |  |  | 4.96 | 4.93 |
| Pa |  |  |  |  |  |  |  | 4.01 |

4.12.2 HETERKS 13

A11 the crasses except $5 \times 6,5 \times 7$ and 7xe had racorded signifitant hateroais avir bettar parent and out of these sightasn crossus had shown positive heterosia (Table 62) . Highest pusitive heterasis hase abservad for $2 \times 5$ 。

### 4.12 .3 GCA EFTECTS

In E. 1 , out of Piva aignipicant erasons for gea sffect, only P2 had positive offaet and there were no significant diffaronees praant among erosens having nagative sffects (Tabia 63). In E2 excapt P5 all othar parente had signSpieant gea opfects (tabln 64) . Unly P7, p2 and pq had significant and pasitiva offact . P7 wns absarverd to be aignipicantly superiar to p2 and P1 . Lowset, significent and negative gea affact was ruearded by Pa . In E3, all parants had aignificant gea effeet (Tabla 65) . Four parantn $\forall 1 z=; ~ P S, ~ P A, P 2$ and $P 6$ posseasad positive afPucta . P5 thaugh did not differ significantly Pran P4, wes Pound to be suporior to P2 and P6. Far nagative afiact, 3 . gecorded bignificantiy dowigr yea affact an comparad to othara. In E4, anly Pour parants racordad aignifieant gee efracts (Tabla 66) .


Table 62
Heteroain par nunbar of effective lancing per eapsule (Fooled deta)

## Heterosisi

Crasona
Ovar iabler parent Dyer mid parant value

1x2
$1 \times 3$
$1 \times 4$
$1 \times 5$
1x6
$1 \times 7$
1x8
$2 \times 3$
2x4
$2 \times 5$
$2 \times 6$
$2 \times 7$
$2 \times 8$
$3 \times 4$
$3 \times 5$
$3 \times 6$
$3 \times 7$
3x8
$4 \times 5$
$4 \times 6$
$4 \times 7$
$4 \times 8$
$5 \times 6$
$5 \times 7$
$5 \times 8$
$6 \times 7$
$6 \times 1$
$7 \times 6$
16.15*"

- $6.99^{\text {" }}$
- $7.98^{* 4}$ $5.97^{\circ}$
$30.31^{\circ 0}$
- 6.45 *
$12.61^{\circ 0}$
$-3.06^{*}$
$9.66^{* *}$
$47.32^{\circ}$
$26.34^{\circ}$
$5.65^{\circ}$
$11.36^{\circ \circ}$
$13.24^{* *}$
$6.55^{\circ}$
9.61
- 8.06
- $5.02^{\circ}$ $6.30^{\circ}$ $4.20^{\circ}$
10.48
$6.72^{\prime \prime *}$
- 0.46
1.01 $41.71^{\circ}$
$-10.48^{\circ}$
17.23
- D. 8 O
$16.67^{\text {e* }}$
- $6.37^{* *}$
- 5.60 ${ }^{\text {w }}$ $8.13=0$
$36.34^{\circ \circ}$
$-2.11^{\circ}$
$19.3 a^{* *}$ 1.99
12.99**
$49.66 *=$
$31.62^{* *}$
11.02 ${ }^{\text {an }}$
17.5500

15. $42^{* *}$ $9.42^{*=}$
$15.40^{* *}$

- $4.40^{-0}$
- 1.28
11.21
11.71**
12.76"
15.ase
2.13
7.73
47.310 m
$-2.20^{\circ}$
$18.82{ }^{\circ}$
$9.45^{\circ}=$
- Signifiuant at 5/ luval
*s Signifieant at is lavel

Table 63
Gea offacta (diagonal) and aca (off diaganal) effacts for numbar of effactiva lancing/plant in $8 \times 8$ diallel of oplum poppy in E 1


Table 64
Gica affects (diagonal) and sea affects (off diaganal) affaets for numbar of effective lancing per plant in bxe diallel of opium poppy in E2

| Parent | (Ranzatak) |  |  | (LL3) (up | PG | $\begin{gathered} p 7 \\ \text { (Hafenea) } \end{gathered}$ | p9 <br> lania) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | $0.117^{\circ *}$ | $0.473^{*=}$ | - $\quad 0.538^{* *}-8.864^{* *}$ | 0.661** | 0.2940* | -0.06B | 0.453** |
| P2 |  | 0.1590* | - 0.050 -0.27600 | $0.319^{\circ 0}$ | 0.60200 | -0.100 | 0.731 en |
| P3 |  |  | -0.465** -0.022 | -0.027 | $0.536^{\circ *}$ | -0.44600 | 0.395** |
| P4 |  |  | 0.23100 | -0.093 | 1. $160^{\circ *}$ | 1.498** | 0.049 |
| PS |  |  |  | -0.024 | -0.12500 | - $0.403^{\circ 0}$ | -0.066 |
| P6 |  |  |  |  | -0.297e | - $0.0 .644^{\circ *}$ | $0.187^{\circ 0}$ |
| P7 |  |  |  |  |  | 0.395** | 0.195** |
| Pe |  |  |  |  |  |  | $00.116^{\circ 0}$ |

* Signipicant at \% Lavel
*significent at 㑕 Level
$\begin{array}{ll}\mathrm{SE}(\hat{\mathrm{g}}) & \geq 0.09599 \\ \mathrm{SE}(\hat{\mathrm{gI}} \hat{\mathrm{o}} \hat{\mathrm{j}}) & \pm 0.02569 \\ \mathrm{SE}(\mathrm{Sij}) & \pm 0.05209\end{array}$
${ }^{5 E}(5 \hat{i j}-\hat{S i k}) \pm 0.0770 ?$
SE $(\Omega \hat{j} \hat{j}-\hat{S 1 k}) \pm 0.07266$


## Tabls 65

Gea sffecta (diagonal) and sca effacta (off diagonal) Por number of affective laneing/plant in ExE diallel of opiun poppy in E3

| Parent | p1 (Aanzatak) | $\begin{aligned} & \mathrm{p}_{2} \\ & \text { (OC6) } \end{aligned}$ | $\begin{gathered} \text { P3 } \\ \text { (Talia } \\ \text { 1) } \\ \text { (Irrianian) } \end{gathered}$ | (LL3) (4) | $\begin{aligned} & \text { P6 } \\ & \text { Whita) } \end{aligned}$ | $\begin{gathered} \text { P7 } \\ \text { (Hapamea) } \end{gathered}$ | $\begin{gathered} \text { PQ } \\ \text { (Gelania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | -0.336** | 0.385** | - $-1.193^{\circ 0}-1.469^{* *}$ | -1.561" | 3.040 ${ }^{\text {\% }}$ | -D.069 | 0.557** |
| P2 |  | $0.267^{46}$ | - $-1.156^{\circ *}-0.572^{\circ 0}$ | 1.886"3 | $1.127^{\circ 0}$ | -0.142 | -0.816 ${ }^{\circ}$ |
| P3 |  |  | -0.215** $2.210^{\circ 0}$ | -0.40200 | -0.649* | $0.330 * *$ | -1.34400 |
| P4 |  |  | $0.421{ }^{\circ}$ | -0.198** | -1.907** | -0.526** | 1.0100* |
| PS |  |  |  | 2.483** | -1.329** | - $0.0 .32 \mathrm{E}^{\circ}$ | 4.308** |
| P6 |  |  | f |  | 0.202** | -0.407=0 | -1.121** |
| P7 |  |  |  |  |  | -0.4990* | -0.790** |
| PB |  |  |  |  |  |  | -0.3250* |

*SIgnipieant at $\%$ level
enignipicant at $1 \%$ level

| 36 (0i) | $\pm 0.02403$ | $\left.55_{5 \hat{i}} \hat{j}-5 \hat{i k}\right)=0.1090$ |
| :---: | :---: | :---: |
| ${ }^{14}$ ( $\hat{g} \hat{1}-\hat{\mathrm{g}}$ ) | $\pm 0.03633$ | SE (2îjusik) $\pm 0.102 \mathrm{l}$ |
| ${ }^{5 E}$ ( s (j) | $\pm 0.07367$ |  |

Table 66
Gea effocts (dfagonal) and sea effacts (off diagonal) for number of affactiva lancing/plant in axa diallel of opium poppy in E4

| Porent | $\begin{gathered} \mathrm{Pl}_{1} \\ (\text { Ranzatak })(\mathrm{PCE}) \end{gathered}$ | $\begin{gathered} \text { p3 } \\ \text { (Telia 1) } \end{gathered}$ | $\begin{aligned} & \text { PA } \\ & \text { (Irrianian) } \end{aligned}$ | $(\mathrm{LLS} 3) \text { (UP }$ | $\begin{aligned} & \text { P6 } \\ & \text { white } \end{aligned}$ | $\underset{\text { (Hafomaa) }}{p 7}$ | $\begin{gathered} \text { PQ } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $p 1$ | $-0.027-0.352^{\text {a* }}$ | . 0.146 | 0.199 | 0.609"* | -0.356\%* | -0.46a** | -0.3600* |
| 82 | 0.001 | -0.212 ${ }^{\text {a }}$ | -0.159 | -0.109 | - $0.389^{* *}$ | - $0.504^{\circ}$ | 10.342"* |
| P3 |  | -0.187** | -0.011 | 0.28900 | -0.196 | -0.268** | 0.210* |
| P4 |  |  | -0.2100* | 0.182 | 0.127 | 0.375** | -0.127 |
| P5 |  |  |  | 0.040 | -0.513** | -0.235* | $0.623^{\circ}$ |
| P6 |  |  |  |  | 0.005 | 0.180 | 1.283** |
| 97 |  |  |  |  |  | 0.10700 | - 0.114 |
| P1 |  |  |  |  |  |  | 0.269** |

- 5lgnipicant at \% lavel
**SIgnificent at 1 Is invel
$\begin{array}{ll}S E(\hat{i}) & \pm 0.03386 \\ S E(\hat{g i}-g \hat{J}) & \pm 0.05119 \\ S E(\hat{i j J}) & \pm 0.10380\end{array}$

$$
\begin{aligned}
& 3 E(s \hat{j}-5 \hat{i k}) \pm 0.1536 \\
& S E(5 \hat{j}-5 \hat{i} k) \pm 0.1448
\end{aligned}
$$

affecte . Two athes significant porent having negative gea affacta wara ot par .

In pooled anaiysia, saven parents recosded slgnificant gea offncta (Table 67). Only threa paranta vize, P2, PS and P4 passasand pasitive gea offact . P2 (.219) wen Pound ta bu significantly auporior to other two which in turn were at par . Though 䧋 (-.073) had Iowest adgnificant gea affoct, it was Paund to be at par with P6 and P3.

### 4.12.4 BCA EFFECTS

In E. 1 twenty Pive (Pourtean with positive erfacta) crosans had aignipicant sca offecta (Table 63). Ameng crosses passussing positive epfoct, crasa $2 \times 5$ was found to be aignipicantly suparior to ranaing crasaess . Luwast algnificent and negative value was racordad by $5 \times 8$ but it wes found to oe at par with 3 athar orasess - in E2, twenty eronaen wera found to pasaman aignificant aca effect out of ahich thistean had pasitivn effacta (Table 64). Crasa 4x7 was abservad to be significantzy auparíor to resaining arosess having positive affacts . It wan Pollows by $4 \times 6$. Significantly lowast nagetive ano effert wos recurded by $5 \times 6$. In $E 3,3$ twenty $a i x$ equasea had alundificant aca effacta (Trable 65) . Wut of nina algnificant and

Tabla 67
Gea mpfects (diagonal) and aca spfects (apf diagonal) Par number of apfactive lancing/plant in Bxe diallel of apiun poppy (ovar enviranment)

puaitive affact possasaing crassang, 5xB tas significantly supecias guar rast of tha orassaa. It taa pollowad in agtur of significance by $1 \times 6,3 \times 4$, and $2 \times 5$. Crasu $4 \times 5$ and $5 \times 7$ were at par out racardad algnificantly lowar negative sea effegt than fiptan ather erasses . in E.4. seventaan eramas racorded aignificant ace affact and aut of thase uight had positiva opfact (Table 66) . Crasa $6 \times 8$ was gignificantly superior to the ramaining erosases having positiva effact . Ha significant diffarancaa wera abserved anong crossas having nagative offents.

In pooled analyain, eightasn crasess had significant sea affeet and out of thass ning had pasitive efpects (Tabla 67). Crass $2 \times 5(1.345)$ thaugh did nat differ signifigantly frua $5 \times 8(1.187)$, wan figund tobn
 par with $1 \times 6$. Lawast, aignifigant and nagativa sea upfect was racurdad by $3 x 7$, unt it dia not diffar algnifleantiy Pran $1 \times 5,1 \times 7$ and $3 \times 8$.
4.13 HORPHINL. PGRCL.NTAGL

### 4.13.1 Pag 县 PKRF Lithtace

Thaugh p2 (19.68\%) did not diffar significantly from $\mu 3$ ( $10.56 \%$ ). It wail found to be superior to ramaining
parents (Table 6B) - fimang crosuan $2 x 4$ (10.47i) rucorded highast morphine percontoga but it was Pound tube at per vith sixtaen ather arossag.

It wan sbaurvad that Por this eharagbar, nurnai sowing anvironmunts during buth year op tasting (E. and C3) verce significantiy superior to late sowing enviromanentu (E2 and E4).
4.13.2 HETEROSI5

Gnly twalve aconsan recardad ainndPicant hateraals over bottur parant, but only twa out of thasa vize, $4 \times 6$ (18.5\%) and $6 \times 0(10.01 \%)$ racarded signiPlaant pasitive hatargeis.

Tabla 68
Horphine percantage of diffarent genatypes (mean of Pour anvizonsants)

| Parent | (Ranzatak) | $\begin{gathered} \text { P2 } \\ (\mathrm{DCL}) \end{gathered}$ | $\begin{gathered} \text { P3 } \\ \text { (Telia 1) } \end{gathered}$ | (Irrianian) | $\begin{gathered} \text { P5 } \\ (2 L 3) \end{gathered}$ | (up | $\begin{aligned} & \text { P6 } \\ & \text { White) } \end{aligned}$ | $\begin{gathered} \text { P7 } \\ \text { (Hapenca) } \end{gathered}$ | $\begin{gathered} \text { P日 } \\ \text { (Galania) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P1 | 6.89 | 10.06 | 8.38 | 9.49 | 6.78 |  | 8.82 | 8.48 | 9. 136 |
| P2 |  | 10.68 | 9.21 | 10.47 | 9.79 |  | 9.38 | 10.16 | 10.38 |
| P3 |  |  | 10.56 | 8.09 | 8.44 |  | E.96 | 10.16 | 9.66 |
| P4 |  |  |  | 8.71 | 9.37 |  | 9.213 | 8.93 | 10.40 |
| P5 |  |  |  |  | 8.57 |  | 9.28 | 9.79 | B. 48 |
| P6 |  |  |  |  |  |  | 8.79 | 10.07 | 9.67 |
| $P 7$ |  |  |  | 1 |  |  |  | -9.59 | $8.69$ |
| PE |  |  |  | 8 |  |  |  |  | 8.77 |



Table 69

Hetarosis Por morphina percentage

## Hetarosis\%

Crastags Dvar batter parant Qver aid parant valua


[^8]
## CHAPTER

DIaLuasidn

Crop improvemant aork in opium pappy is, in genaral,
a twa dinemaignal appraach 1.0. improvamant iñ latex yiald and breeding for high marphino types. Racentily with incrassing gost of oplum saud (pasta-dana), the third dimension of sasd yisid is alas sdded to tha breading programase . Cualution of new variatias, genarally pragrasand with collaction of gmemplasia and axplaiting it sittiar por direet ralwasa of the typas ar by utiliming in braading programan (Vad Kaj Hanrik, sen, 1970; Nigam et ad, 1979, 19e2)。 Parformance of Duten, Czachelovakian, tulgarian, Gezman, Asian origin snd Lasit typas nave tann reportad in 11terature (HLavackove, 1955; Zoahke, 1962; Andraus, 1763). In Indka opiun poppy rassarch lack skarted with agranomical triais . fecentiy, Nigan ( $19 a 0$ ) rapartes avolution ap twa naw opium varieties for 1 H.P. region ap India .

The utilization of availuble variability in cultivatas's fiald is In prograsis, but far Putura braeding programme esthef nots variabiliky ta to be oreatud ur avallsbla variabilitien are ta be utilisad Far battor yields, or possibilitian of now myarido in aplum poppy naed ta be axplared, Having these abjactives in mind,
a Bxa tinilad eroas uas undertaken at Mandaaur.


#### Abstract

Latan yields 48 ane ap the mast impostant characters, whien ia diructly and ponitivnly garralatad whth laaf area (Prasad, 19a0), atam ifamater and number of atigmatic rayz per capsule (Prasad 1980; Hosmwtiz 1930, Khanna and 3ingh 1975) . Soud yisid \&is diractiy and poaitivaly correlatsi with number of capaules per plant (Prasad 19a0, Marumbiz 1930; Khanno and 4 ingh 1975). sapeula siza (Khanma and Singh 1975, "racad 1990), number of stigaatic raya por capsula (Prasad 1980, Khanna and singh 1975) and Leaf arad (Prasad 196a). Marphina peraentage is positively correlatad aith leaf arme, mamber of stigantla gays par capoula, suac $y$ isid and plant haipht (Prasad 1980 ), but is nat correlated with number of enpsules par plant (Prasad 198a) *


Environmental agancioo blay an important role in opium poppy * Nioan squareq Por anviromaents in pooled analysia was highly significant indicating that artipieially ereatud envixammenta unre effective as different amuixanmenta.
 follawed by its intarastians rad than by ganotypio uompanantn, Por all charagtera. This indieakan that onariaters atudiad had differantial expressian in diffarent anulrommanta, find


Influances by anvixamental agancias.

Paoled analysin indicated significant differances amang ganotypas Por all the eharactars . In the present discussian oniy resulta prom poaled data hava bean conaidered, excapt Por stem diameter, for which the dipfarances in only E. 4 wasa significant .

Highly signspicant diffarences among parantal lines alasily establishad that these lines ware gnnatieally diversa for all the attributna . Significant difforancas bera alsu noticed asang the hybrida Por all the eharacters The comparisan of parants Vs hybrid as a group is indicative of over all expression of haterasia and alsa cunfiraed tha prasence of ganotypio divarsity anang parantal lines, ginco the differences were observad ta be signdficant for all eharacters exeept morphine percentage .

In presunt invastigation, pasitive and significant hetaroais was pbsaruad in mast of the crossen far plant height . The findinga are in agraunant with thaes of H2avockava (1959) and Sarkany 易 al-(1959) * The plant huight in upium pappy gas raportad to bo a highly hertzable charactar (HInvackavii 1972) . Combining ability analysia ravasiad that plant halght is doterninad predominantly by additive gene action. Hawaver nan ndditive gunatic variance
was siac playing an important role in its axpression. Hapemea (P7) had positivet and aignificant gea effects for this eharacter . None of the crassas had signipicant sea effocts in negativa diraction.

Leap arad is the single mast impartant Pactor Por agsicultural arap yialds (Vatson 1956) . Conbinimo ability analysis Indicated that this aharacter is governead both by addicivo and nan additiva gane actian. In the prosent study, haterosis por this character was also obaservad - Since larger laaf aral is dasirable in oplum pappy, parental inas showing gea offocts in pnoitive diraction were desirable - Paranta P2 (OCt) and PS (LL3) rocardad significant and pasitiva gea appacta Por this attributa, and tharafora, wern dasirable conbinarn - Among hybetds, Pive ( $2 \times 5,2 \times 6,3 \times 1,4 \times 7$ and $5 \times 8$ ) eombinations possasand significant and pesitivn sca offeets .

Signlfigant diffaranean wers onsasvad amany Enirty aix genotypas Por stom dianatar andy in anviranmant E4. Combining ability anslyase auggestad that ainoe gea and sea variance wera equal in propartion, bath additive sid nan additive gane actian ware important Por this attribute . Hetaruais wan also racorded for this oharactar in buth diraction. Parental linas with thieker stam dianatar wauld an dasirable . Parants "1 (Ranzatak),

P3 (Telia 1) and PA (Irrianian) were deairable cambinar sinces they had significant gea afpoct in pasitive diraction fimong crossus, nine combinations wero Pound to possasa significant and positive sca effects .

In the present invantigation, it was found that, genotypes differad significantly for number of capsula per plant in E2 and E. 3 anvironmonta only - Combining ability analysia (pooled) revealed the fact that gea and sca variances wars highly signspicant, with graters magnitude of gea variance, suggasting that though, both additive and non adrlitive typa of gena action are important, the prodaminant rale ia played by additiva varlance far numbar of capsulan par plant. Haterasia was noticed Por thia character, which is in ounfirmation with Pindings of Papav㫙 al-(1976) and singh $A$ Khama (1975).

Parant P4 (Imfianian) and P5 (LC3) had gen afrect in favourabla diraction and thase parants can be unad to imprave this charactar in future braediny programa . Among crosses, thraa cambinations vizeo $4 \times 6,4 \times 5$ and $5 \times 8$ ean be idantified as having favourable diraction of sea affactil .

A11 componante of variation wasa Pound ta be significant in poolad analyais for capsule aixa . Hatarania for thle atcribute sas observad in the presente study, ad
alac reported by Hivasi (7923), Sarkany (1959), Mraz (1964) Dands (1963) and lamiftrav (1963) . Barkany (1959) raports 10.67 parcent positive hybid uigour for thia charactor in this naterbal, whare an in the pressat study a maximum of 12.11 percent positive heturosis suar bettar parant was sbnervad (crasa $9 \times 6$ ).

Combining ability analysia zavealad the significance of both additive and non additive type of gane action for capsule aize . Addítive componant wab morn impartant aa rtafloctad by granter manan squares of gea. Parental lifnas efth groatar eapsuln size would bo desizabla and thereforo, gea affaces in paaitiva dfraction could bo takan to imply deairable eombiners. Results of present atudias suggnatad that p7 (Haremea) was opsazuad ta as bast combiner . fimang cronsen, $7 \times 6,4 \times 7,5 \times 6,6 \times 7$ and $4 \times 0$ whra gaod spacific cumbinations for thia enaractar .

Huatare of atignatic saya por sapsule in an important character in oplum poppy besauna it haa poaltive corralation with latex and weed yiald (Khanas \& Singh 1975 , Horouts 1930 and prasad, 19a8), and with that of mopphine percantage (prasad 19e0). All tha parantal $11 n \mathrm{na}$ and erwase diffar aignificantiy in pooled analyaia inafeatime penatie divorsity in the satorial. Prasent otudy indicatad presanea of haterasis for inis attributa. Ho athar rapert sas
available for heterosis for this character .

Combining ability analysia ravaled the significance of bath additiva and non additive typa of gann actions por thia tharaater. The gea variance was of highar magnituda . Since nore numbar of atigmatic rayb per capsule is a desirable character, the ines with poaitive gea opfecta wauld be deairable . In the prasent investigation, P7 (Hapmmea) and PB (Galania) wore Pound to be the bose combinars - heang crosaus, $5 \times 7$ wan bant specific combinatian Por this character, though as many as aightaan other arosags also had positive and significant ses affacts .
[conomically, latax yleld in opium poppy is mast important character . Thia charactior sas raparted to menanes positive corralation with laaf araa (Prasad 1980) and thos of inumbar of stigmatic rays (Horawtiz 1930, Khanna and \$ingh, 1975 , Prased 1980) .

Genatic divaraily por this chazactar in parantal Ifmes sas indicatud by analyais of varlance , Moaitive and digndificant hatarguls was obaurvad Por this charanter in prasent invastigatian, and was also raparted by maveral warkers (Nalcvavaka and Popsvaka 196?; Oinltrov 1966, Singh and Khanna 1975; 5aint and Kaiekar 1980).

Pradaminance of additive genetic variante in its oxprasion was indicatad by the highly aignificant genneral numbining ability variancen Uon additive genatio variance also playgd an important rolo. Hawavor, ita magnitude was leas than that of additive genatic componant. The pradominance of additiva genetic varianes in tho axpreasion of latex yield was alao saported by Saini and Kaicker (1980) In the other hand, Khame (1975) abonrved the pradarinance of non additiva genatie componant .

Qbviausly, parants having pusitivo gea offacts are the best combiners POF latax yield . P4 (Izrianian) was Pound to be significantly superiar tombiner - P3 (Talia 1) and pg (balania) wera alan dablrable onmbinara . As many as sixtaen cronsas had signipicant positiva aca affacte . Howaver, 2x5, 1x2 and 3x4 wara aupaztor and therefora ean be treatad as most danirable spacific combinatians -

Genetic diversity was naticod in prasant investigatian for ased yisld. With inarnasing gont of grain, this aharactar is likely to anouan granter ispartance in futura breading programses . hs aarly an in 1955; Anderaon and Laot, raperted that graater attention mhould the paid ror sasal yisid instaad of norphing parcontage bacaune in tine
ta came thia will be unprafitabla anterprian .

In the prosent atudies, pasitive hetaroais aunt better parant warn abserved in many crossen. Heterasia in pasitive diraction par smes yiald was rapoetad by 3everal warkurs (H1avackova 1959; Sarkany gt at 1959; Keskave 1963, Diaitrov 1966; Hiczulska 1967) . Tha rosults of presant studies wara canfirmatory with thasn marlier Pindings.

Combining ability analyain rasults indicate tho priadominance af additiva gmeactian Por this charactar, though non additivg gana action was alao important . Khanna (1975) abservad predaminance of additiva genae for espsula waight . Tha rasulto of prosant invastigation are in aprammat with Pindings of Khanna (1975).

Desirabla parants for anad weight anre idantifiad by positive gea affocta. Thraa parants vize, P6 (UF uhite), pS (LL.3) and PA (Irrianian) wora Paund to be wuparior canbinazs Par this aharacter . Amang eraaser, $4 \times 6,1 \times 6$ und $4 \times 5$ were auperior anabinatisns for aad yiald in oampizasion to readining erosean .

Ganntic divarsity was found to unsiat Pat
husk yield in tha material under atudy. Heterosis was abserved Por thia charastar in the prasent investigation . The result of combining ability analynis revaaled that bath types of gens actions vizes additivo and nan additive, govern the inharitance of this charanter, thaugh pradaminant role was playnd by additive ganetic variance .

Dasirabla parant for husk yiald mara idantifiad *3 P4 (Irrianian), P5 (LL3) and P6 (UP whita), which had racorded oignificant and positive gea offacts - Among cransen $4 \times 6$ and $5 \times 8$ were significantly suparior combinations.

Genatie variability was abserved Par number of effective lancing per capaule in prasant study . Wo reporta zere availabla for enis anaracter. Hintorosia in pasitive diraction in mast of erasaus whry ohagrvad .

Both gen and sea variancas were slgnifigant, howaver, the latar was about three times laryer in magnitudes, Indiceting the prodaminanca of non additive gana action . P2 (DCB) was suparior parant having significantly highar magnistude of gea affacts, than all ather paranto . Howovar, p4 (Irxiandan) and D5 (LLY) with uignifigant gen effenta bere also desipable parants - Anang arasesen, $2 x 5$, and $9 x$ 有 werm Dest combinations having pasilive and nignifioant aea offacta . Erass $2 \times 5$ alac had algnificantly higher value
af sca offeats Por latex yiald. Thus, number of affactive lancing par capaule could be considared as an offactive critarian in tha salaction for latax yiald.

Parants and hybrid differed signifitantiy and (P Vs H) interaction was Paund to be nun aignificant, por morphina analyais in RBD anslysis. Jignifieant hetarasia in pasitiva diraction was observad only in ten crassan vize. $4 \times 1$ and $6 \times 2$. $5 i n g h$ and Khanna (1975) also roporterd poor hatarasia for morphine cantent. Intarmediate morphins typas wara raportad by Hlavackova (1959) and Popov et al, (1971). Hownvar, pasitive hetarnsis for thia gharactar was obsorvad by Oanos (1965), Anderson and Laot (1966) and Kopp and Kotil1a (1955) . Braoding for high marphinn cantant can be achiavad Indiractly alnaa aaed yialif is pasitivaly correlatas with it (Voskerrusa 1960, sehcader 1966) and accarding to Kapp (1957) Large baar shaps capsuln contains ack masphins .

Tha eroanob having gead narphina parcantage wera; $2 \times 4(10.47)$, $4 \times 8(10.40)$, $2 \times 8(10.38), 2 \times 7$ and $3 \times 7(10.16)$.

On the basia of the rosulta obtainad and discusend an Pary the choice of best conbinnx paranta aa well superior eross cambinations far the diffarant sharactars can nam tue identified *

The apium erop is valued por its intex. It is therefare, imperative that farmers get not anly gaod saed yiald buts alsa latex yiald . Combining abllity analyala identified thres parantal linas as moat desirabla for this trait vize. P4 (Isrianian), P3 (Telia 1) and PB (Galanta) (Table 70) . Parant P4 had significant gea affact for, latax yield, number of offectiva laneing, number of stignatic rays, seed and husi yleld; P3 had aignificant gea affects Por latex and number of affoctiva laneing and PB had significant gea offact Par latex, stam diamater and numbur of stigmatic rays.

Seed yisld is anothar important charanter and Por which. HS . PG and P8 wera idantipied an danirable parant basad on combining ability analysis. PS (LL3) had signipleant gas apfact for sand yiald, nuak yiald, laap arga, and number of stipmatic rays (Table 70); P6 (UP white) had signifigant gen offact por saad and husk yiald and Ps (Gelania) had significant yca offacta Por wand yiold, numbar of atigmaten raya and stom diamoter.

Thus for latax yiald best canbinar identipiad in P4 (Isrianian), Por sead yinld it ia PG (up White) and Par latex and sead both, it ia PA (Irgianian).

Table 70 Danirable gea offecta of parante and sca apfecta in crosess par different characters

Genntypes Significant affacta Por charactars

| P1 |  | CH 3 |  | CH6 |  |  |  | ${ }_{\text {CH1O }}^{\text {CH10 }}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| P3 |  | LH3 |  |  | CH7 | CH | CH9 | CH10 |
| P4 |  |  |  | CH6 |  | CHB | CH9 | CH10 |
| 05 | CH2 |  |  |  |  | СНе | CH9 |  |
| P6 |  |  |  |  |  |  | CH9 |  |
| P7 |  | $\mathrm{CH3}^{3}$ | CHS | CH6 | CH7 |  |  |  |
| 0 |  | CH3 |  | CH6 | CH7 | CHa | CH9 | CH10 |
| 1×2 |  |  |  |  | CH7 |  |  |  |
| $1 \times 3$ |  |  |  |  | CH7 |  |  |  |
| $1 \times 4$ |  |  |  |  |  |  |  |  |
| 1x5 |  | CH3 | CH5 | CH6 | CH7 | CH8 | CH9 | CH10 |
| $1 \times 6$ $1 \times 7$ |  | CH3 |  | CH6 |  |  |  | CH10 |
| $1 \times 8$ |  |  |  |  |  |  |  |  |
| 2r3 |  |  |  |  |  |  |  |  |
| 2x4 |  |  |  |  | CH7 |  |  | CH10 |
| 2×5 | $\mathrm{CH}_{2}$ | CH3 |  |  | CH7 |  |  |  |
| 2×6 | CH2 |  |  |  | CH7 |  |  |  |
| 2x7 |  |  |  | CH6 |  |  |  | CH10 |
| 2×8 |  | CHS |  | CH6 | ${ }_{\text {ch7 }}$ |  |  |  |
| $3 \times 4$ $3 \times 5$ |  |  |  |  | CH7 | CHB |  | CH10 |
| $3 \times 6$ |  |  |  | CHG |  |  |  |  |
| $3 \times 7$ |  |  |  | CH6 |  |  |  |  |
| $3 \times 8$ | CH2 | CH3 |  | CH6 | CH7 | $\mathrm{CHE}^{\text {che }}$ | CH9 |  |
| $4 \times 5$ |  | CH |  | CH6 |  |  |  |  |
| $4 \times 6$ $4 \times 7$ | CH2 |  | CH5 | CH6 | CH7 |  |  | CH10 |
| 4x8 |  |  |  | CH6 |  |  |  |  |
| 5x6 |  | CH3 |  | CHá | CH7 |  | CH9 |  |
| $5 \times 7$ | CH2 | ch3 | CH5 | CH6 |  | CHB | CH9 | CH10 |
| 5x8 |  |  | CHS | CH6 | CH7 |  |  |  |
| $6 \times 7$ |  |  |  | CH |  |  |  |  | $6 \times 6$ $7 \times 8$

CH1 = Helght; CH 2 = Leaf aras; CH = 3 Stan dianetery
CH4 = Number of cepsules per plant; CHS - Capsule alzo CH6 = Number of atigmatio rays/capsula; $\mathrm{CH}=7$ = Latex ylaidj CHE = Send ylald; CH9 = Huak ylald; CH10 $=$ Humber of affective lencings/capoula.

Dabirable sca sffacts por nore than ona charactar Por different crossas ara prasentad in table 70 . A gomparision of dSpparant significant arassas Par latax and masd yiald, in tatms of latax yiald, siead yiald and morphins percentage is also prasentad in Table 71.

Hased on the specific combining abillty apfacts, crosaen $2 \times 5,1 \times 2$ and $3 \times 4$ ware found ta ta demirable combinations for latax yiald . In the other hand orasess $4 \times 8$ and $4 \times 5$ wera the top mas combinations por latax yiald. on tha basia of gat an performance of ayucida. Thera is thus no agreemant batwen tha Par so porformance of the erose and-their sca apfocts. Jatesra and Parada (1979) alaa repartad that thers is na agrosment bstaoun crasana chasan on the basls of $\mathrm{p}_{\mathrm{Br}}$ ge performanes und sea effacta . Unlikn sead yield tha best grass on the besia of aca appact did not invalue buth parents having high gaa affacts. The erosa AxB salartad on Her ga basis, on the ather hand, had toth paranta having high gea apfacta in dairable diractiona . Sinen the parmer is interasted in latex yle 2 d , it will
 mybrid. The segragating proganies of thia arase involving high ged $x$ high gas linas may throw segroganta whiah may be at par with $F_{1}$ in thair parpormance and therafore, it will be warth while to pursue the sagengating watarial.

Table 71 Comparision of significant erosses for latex and seed yield in $8 x$ diallel of opium poppy

| Crosses | Per ss parpormance |  | Morphine\% |  | Remark |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Latex | Seed |  |  |  |  |
| A. LATEX VIELD |  |  |  |  |  |  |
| $2 \times 5$ | . 360 | 8.12 | 9.79 | NS |  | seed yield. |
| $1 \times 2$ | . 318 | 7.55 | 8.38 | PS | Pos: | saed yield. |
| $3 \times 4$ | .411 | 6.68 | 8.09 | HS | Por | seed yieldo |
| $2 \times 6$ | . 338 | 7.19 | 9.38 | NS | Por | seed yield. |
| $4 \times 5$ | . 375 | 9.30 | 9.37 | PS | Por | seed yield. |
| $3 \times 6$ | . 356 | 8.57 | 8.96 | PS | Por | seed yield. |
| $3 \times 5$ | . 360 | 7.40 | 8.44 | NS | Por | seed yiald. |
| $6 \times 7$ | . 281 | 8.109 | 10.07 | NS | Pur | send yield. |
| $7 \times 8$ | . 297 | 6.54 | 8.69 | NS | Por | seed yield. |
| $3 \times 8$ | . 338 | 7.24 | 9.66 | NS | Por | seed yield. |
| 1×6 | . 260 | 8. 88 | 8.82 | PS | Por | seed yleld. |
| $2 \times 7$ | - 278 | 7.14 | 10.16 10.40 | NS |  | sean yield. |
| $4 \times 8$ | . 446 | 7.12 6.66 | 10.46 9.49 | NS |  | saed yield. saed yield. |
| $1 \times 4$ $1 \times 5$ | . 297 | 6.46 | 8.78 | NS |  | ased yield. |
| 5x8 | .293 | 8.37 | 8.48 | PS | Por | seed yield. |

日. SEED YIELD


NS = NonsigniPicant; PG = Positive signiPicant;
Neg. = Negatives
Wotes: Pes ge performance of latex and seed yield in g/plant.

Soad yimid is an important gharaater for which desirishle cambination need ta be identlpiad as in Puturas hybrid Por high ased yield will be requirad e Hybrid 4x6, having buth parente of signipicant gea affect for meed yield perfarmed an top in par gh as wall as far sad effact, and tharafors is tha beat chaisa for sand yiald.

Among the fiva crasaca identipiad far latax $y$ iteld 1.日. $2 \times 5,1 \times 2,3 \times 4$ on aca performancs, $4 \times 8$ and $4 \times 5$ on Par an performence, and one erass ldgntipiad far basd yield, one ur two erassea por further explaitation naed to bs identifiad. For sead yiald arous $4 \times 6$ was mast dasirabla. On tha other hand Par latex (for whion a Parmar mainiy raiaeo his arop) tha crose combinveita $4 x$ was Pound ta bo tha bast. It
 effanta Par $1 n t a x$, non significant sea apract par sead yield, the rarphimn conkent of tha croas baing muah highar than uthar eroasus in consisaration and above all shawing pasitiva, signipicant, heterosia (18.59\%) Por morphinu conkint ovar lastesr pacant *

Tha crasa $4 \times 6$ has nagetiva sea affuet fas $1 s t e x$ YAsid and tharafare, thin gomaination may not be conaiderad Pax fubura commeraial hybstd . Howaver, singe tha parente of this erass ( $P A$ and $P G$ ) ara dasirable ajobinura for saud yiald, as wisil as latex, it can be axpectad that in
sugragating progenies selactions may as obtainad, which ara bettar nat anly for latex yield but alsa for saad


Thua, it can ba aaply concluded that por Puture commerelal hybrid the luast choice will be $4 \times 8$.

The ganezic variancus Por all charactaga axcapt number of effactive sancing pez capsula wore found ta the pradominantly additive, as wall as nen additiva ganotic variancaa wara also impartant . For number of affective laneing nan adGitive varianca wes pradaminant with important zole of additive vaziance .

The additive variance auy bo explalted by tonvantional breeding mathods lika mass selaction, modipiad bulk selectian methad, padfgrea nethod or mess pedigras mathod . In sagragating peagenias of erass invaluing lines P4, p3, and PB ( POR latex yivid) and PA and PG (for send yiald), sugragenta having nigh gea $\times$ high gea cauld bu isolated .

The nan additiva varianas can ba uellizad by using non sunventional methads of braeding vize, blparuntal tantinge, racurrant salation or any other cyelical breaing mathod, of this conpsnant of varianca autd be sxplaited by releasing $\bar{r}_{q}$ hybrida an gammarial hyoeld .

The pressant study therepore, concludas that out of eight parsnts tastad Irrianian ( $\mu 4$ ) is the best nombinar Par latax and anod yiald and up Whita (PG) Par saad yiald anly . Amang erosses the cross $4 \times 8$ in the bust and can be conssdered Par Puture commareial Fi hylurid.

## CHAPTER 6


5.1 SUPWARAY

A BxB diallal in upium poppy was executed aith two parants of Madhya pradash (Ranzatak and Telia 1), two parants Pram Rajasthan (DLE and Galania), ons Prom Lttar pradesh (Up Hhite), teo Pram IARI New Delhi (Lh3 and Hapamea) and ona dratun Prom axotic maturiad (Ierianian) * Normal sowing and one month lata apwing gouplad with two ysars of testiny ernatad Pour dipferent and contrast anviransants . Thisty six genotypas (aight parants and teanty aight hybrida) wers tastad in FBD with thran replication in each anviranment. *

Masn squagas Par all sampanent of variations in RBD Par all charactars (plant hoight, laar araa, nteat dianater, number of gapsulas par plant, eapsula size, latax, saod and husk $y i s i d$, number of sffectiva lancinge par capsula and morphins pescent ) wera Pound ta be significant .

Cambining ability analyila wati perfaraed by following Griffing nodel I method II for all maramtars except marphine percentaga. Compennets of variatian in gumbining ability amalysis mera Paund ka ta nignipieant Por all gharactara, Heterdais was ubagrved Por all
charactars . Hafemea wea tha most undasirable parent for height . Ifrianian waik wat eambinar for latex yiald, sead yield and their components. Talia 1 and Galania wara bettar combinorg for latax yiald aloo. LLB, up white and Irrianian were best tambinars Por sued yield - Irrianian $x$ Gelania (4xa) having higheat pasitive hataroais Por morphine percentage, was found to on ovall bast equbination for latex ylald while Ircianian $x$ up white (4x6) was best combination Por ased and husk yleld, though it possansed negative sece effect por latex yiald.

Additive genatic variance was predaminant for all eharactar axeept for number of afPontfive laneinga per capsule, where nun additive genetic varience in its exproasian bas predoninant . Howevar, rola of additive gonmaction for number of effective lancings and of non additiva jung action for raet of eharucters, alsa wari important.

## 5.2 conclasiun

Irrianian, Tulia 1 and Galania uury bade eumbiner parenta Par latex yield. LL3, up whita and ifrianian aura Pound to be bast cuabinar parants for and ylald. Irrianian * Galania ( $4 \times$ a) was best combination for latex yiold . 1 ryianian $x$ UP White ( $4 \times 6$ ) was bout dambination Por suad and husk yiuld . Both type of ganeaction 1.E. additiva and men
additive wera important fur thesa charactars. Numbar of gffactive lancings per capsula had predominant role uf non additive genetlc variance, while Por qther eharacters, additive genetic varianee had pradoainant role in ite uxpression .

### 5.3 SUGGESTIUR PON FUATHEH WUAK

The Pollowing ralavant auggastians hava been made to highlight the furthar wark of the present invastigation .
(a) The posaibilitias of axpluiting hybrid wigour In opiun poppy ean ta explared by tasting Irrianian $x$ Galania, $F_{f}$ cumbinatian, for cumanreial usa -
(b) The sagragants of twi erassas vize. I virianian $x$ Galanid and Irrianian $x$ up Whita, should to pursued, ts isolate dessrable aggraganta having hiyh gea $x$ high gea campanant, it in puasibla to get sagragants alth high seed as enll ad latex yiald in seggationg-papulatian of thase arasisea .
(a) For aslaction, aancantration shouid be foaused an mare numbar of atigaticic raya, nare number af effactive Laneing par gapaula and capaule siza, Par improving latax and gasa yield.
(d) In apium pappy, eonvantional breading mathads ara suggestad to explait additive genetic varlance for mot of elraracters.
(a) Non conventional breading mithods are suggested to utilize non additive genetin variance, partigularly por Laprovament in number of affective laneing .

## REFERENGES

Andarson, b , and B . Laot (1966). In the erapping value of the poppy through breading (Cisr.) . Pharmazia, 21:240-245.
findreev, $\mathrm{V} . \mathrm{S} \cdot(1963)$. The increasa of axphine cantent in polyplolds of the coman pappy (papavar samniforum L). (Huss). Dokl. Akad,. Nank. LESSR, 148 (1):206-209.
Annonĝ(1979). Ancual raport of opium research project, handsaur
Beguinat, $\mathrm{A}(1926)$. Research on hybrids in sevaral races of Papaver. (1tal). Attio Sac. Haturalisti Madena,4:1-18.
filaringhon, (1925) A aterilu hybrid of Piald popgy (Papavaz somnifarum L.Var.nigrum D.C.) and a uild poppy (Rapavex setiganum D.C.) (Fro) Hull.Sac.llot. Frsnce. 72:623-626.
Elaringham L.:(1932).A Case of atavism appasing in an opium poppy 1 ino ( Fr ). Lumpt. Rand. Hebd. SBariens acad. Sei., 195 (25) : 1192-1195.
Heros, A-(1927) Cancorning Papaver hungacicum Barb. (Huna). liat. Kozlam., 24 (516):212.
Cavara, $F$ and $A$.chistari (1926) Hytaridization and morphina content In papavar gomifarum L. (Ital). Atti.fanale.


Chatonan, $3.5 \cdot(197 B)$. Poppy atraw a naw saurco of Pitiro boards Indian pulp and peper, 32(4)iS-A.
Danos, $\mathrm{B}(1965)$. EPPact of generativa hyaridization on the pattern of alkalaids cantant of the upium poppy.1. Investigation of the Pifnt filial ganaration $\left(r_{1}\right)$.(Gara). Pharmszio, 20(If): 727-731.
 with apecial aansideratian of the typan of alkelalds
 1956(3):363-367.

Faichraing J. K $\rightarrow$ F.llakim and V LL khair (1974). RIkaloidal atorage, metabalism and translocation in the vascielas of Enpayer gannifarua Latex Phytuchainstry, 13.(7):1133-1139.

Furusata, $K$ (1940). Palyplaid plants praducad by Calchicine (Jap.) . Bat. X 20LL. $B(8): 1303-1311$.

Gripfing, 日 (1956). Concept of gans zal and specipic combining ability in raleatian to dialial and releated populatian. Kuat.J.BLal.5el.9:403-493.

Gupta, $R_{*,}$ K.f.Khanna, H.G. 5 ingh and A.S.Gupta (1978) . Status Hapart in Upiun Pappy (Panavaz agmifarum Linn.). AII India Workshop on Epiun Poppy (ICAH) 11 th to 13th Apzil, Udaipur .

Herisast, $f^{\prime \prime}(1967)$. Evalution af the cultivation of the opiun

Mirishi, N.J(1960). Cytaganatical studien on Papaver nannifarum L and Papavar sotigerum DG and their hybrid. Conatica, $31(10-2): 1-130$.
Hirasi, T(1923). Plant brseding expariments with tha apium papay (Jap) - Rap. Imp. Hyg ol.abo,19:289-327.
Hlavackova, $2(1955)$. Poppy braading Par incraased morphino content (Czech). Prasila, 27i368-382.
Hlavackava, $Z(1959)$. Crassing of popples ained the a heightaning of the marphino cantent in dry popiay hoads(Czean) e Ros1t. Vysobs, 32(4):521-536.
Hlavackova, $2(1972)$. Investigation of the Inheritance of the plant haight and send weight in poppy (papavas samiffrum L) (Czech). Ganst. Siecht. (Praha) \% $8(2): 87-93$.

Horowtiz, 日 (1930). 5tudias on opium pappy (papavar agmiforum L) (Pol) Paniotniki Panstwowego Instytutu Hackawago Gospodarstwa Wiepsiklegow Pulawoch. 11(1):159-217.
Hurst. C.C(1907). Mendelian characters in plants and animala. Int.Canf. Ganat., 3rd seport.hart.Soc. 114-128.
Ivanave, RoM (1972). Use of experimental mutagenesis in breeding of papavar gamnferum L. (fus.). Genatika. $8(1): 30-37$.
Jablonski, M. (1967). The influance of spacos betveen the raws and thinning methods on pappy yiald (Pol). Pamisin. Pulatuski. 25:205-223.
Jatasra, D.S and R.5.parada (1979). Heterasis and cambining ability for synchrany traits in what. Imoion Ganat., 39(3):521-528.
Kasaeva, M.A(1929) - Hybridization experimenta between Pagaver somniferum and E. bracteatur. Acad. $3 c$.Ukraina Hull.C1.Sch. Phys.phath. $A(4)=220-233$.
Kasaeva, $H_{*} A(1930)$ - Hybridization experimanta betiveen Panavar somifiszum L and Papavar bractaking Lindl. (Russ). Trudy. Useso Juzn - Sezd.Gan.jalak e Lemanav e Plamann. 2hivatnov. 2:295-306
Kawatani, T and HoAsahina (1959), External chsracter and alkalaida of tha artaricial incorapecifio $F_{1}$ hybrid butwean papaver petantale $L$ and g . gomifierun $L$. Jap.J.Ganat., 34(1):353-362.
Kaskova, E.S•(1963). Intzavariatal and intarvariatal hybridizatian In tha a11 poppy. (Rus). Agrobiolag Ja. 4:619-622.
Khanna, K.Re and A. 5 , Hurty (1973) : proc. Sitaraid Cang.
Khanna, K.R and U.F.Singh (1975) - Corrsiation studias in papaver Hoanifraxum L. and their bataring on yiald impravanant. Plolledica, 28592-96.

Kahoutave, 2 (1953) - Pappy braoding with ragards to oil contant (Czech). Praslia. 25:97-106.

Kopp, E and E. okotilla (1955). Exporianants an impraving the cikaloid poppy (Rum). Stud.Cercet.Sti.(CluJ)Ser.2, $6(3 / 4): 57=60$.

KoppoE(1957) (Rum). Pharmazia. 12:614-620.
KopppE, E.Katil2aes KoLrado and Sollatyas (1961). Further attampts at breeding a pappy variaty rich in alkaloids (Gar). Pharmazio. 16(4):224-231.

Korhoda, $J$ und I miczulaka (1962) o A trial of taking idvantaga of heterosis in breeting and sead production of pappy (Pa1). Pbaintio Pulamski. 5:5-14.
Leake, Holl and E-R.pershad (1920), A prallminary note an the Ploumr colour and sssociatad characters of oplum pappy. J.Genat. 10(1):1-22.
Lagg, P.D., J.F. Chaplin and G.E.Collina (1969); Jatiarad. 60:213. Lorinz, $G$ and $P$. Tetanyi (1963). Rasult of our exparimants in Interspacific hybridization in Papquge. (Hung) oherba. Hung. 2:127.
Lorinz, G and P.Tstanyi (1966). Distant hybridizution tutanen Papaves monnifarus and E.gRiantale. (fus). Harba. Hung. 5(1):95-105.
Michalaki, T (1959). Polyplaidization of medicinal puppies, Rapavier goranifarui L. ( Pal ) . Jull.Instafosiin. Laezniezych - 5(1):63-67.
Hiczulskag I (19a7). Hetarania effaet in hybrida ap eartain Variatiea of poppy (papaugs manifarun L). (Pol). fociznalank.iralne: Bar.A, Rosine 93:197-204.
Lyake $K$ and $Y$.Imai (1927). InTheritanae in papavas somdferull. prac.Impelicad. Japan. $3(3): 169 .-170$.

Morasz，$S(1960)$ ．Incruasing marphine content of poppy with controllod delf pollination．（Hung）．Harbactung． 5（2／3）：127－130．

Morice， 2 and JaLouarn（1971）．Study of morphine cantant in the 0.11 popay（Papavar somndPGrum L）．（Fr）．Annofmolior P1．21（4）：465－484．
Mrazaf（1964）．A method Par datermining the ohare of the ＂Heal th affact of hetarosia＂in yiuld affunt．（Eznch）．月ast1．Vyraba．10：909－912．
c．
 $12: 144-145$.
Nigangk．a．，g．K．Jain and H．C．Chaursaia（1979）．Evaluation of ganetic variability in oplum pappy（Panavar ananiforum L ）in Madhya Pradeah，JNKVV \＆Res．J． 13（1－4）：98－99．
Higam，K．日（19日G a）．Reluana proposala of twa aplum poppy varietiea Por नadhya pradesh ．proc．IV All matiorkshap on HEAP． （ICAH），Madusai．
HLgan，K．E．，G．S．Rawat，K．C．Chaurasia and Sok．Jain（ 1980 H）． Salient acheivemento and recommendation in ppium poppy Par Madhya pradash ．Proc．IV All Madiarkshop on M\＆AP（ICAR），Hadurai．
Wigam，K．B．e g．K．Parikh，K．L．3athi and R．Lupta（1902）．Genutio variability in opium poppy（papavar agnndforum L）in Madhye Pradash．JwKVV．Ras．3．76（2）．
 JuKVU．月．as．J．（In preay）．
Pansa，V．G．and．P．V．Sukhatine（1954）．Statiotical methade Por Ageigul tural larkara．Pub．icar．Haw Deind． Pirovano，A（1927）．Wusult of hybidization betwean papavet agiandfaryit $L$ and P．bracteatum（Ital）．Annelint． 17（4）：171－194．

Remuse1, C(1959). Nutations induced by $X$-ray treatment (Span), Heviata.Acgent.Agron. 26 (3-4):108-109.

Saini,H.C and U.Sakaicker (1982). Combining ability analysis Por opium yiald in oplum poppy (papavar gomniforum L), south. Indiau flart. 30(1):32-36.
Sarkany,5., B. Danas and I.Sarkany kias (1959). Studies an hateroois effocts in puppy hybrids (Ger).AnneUniv. Sci. Budapant Ralendo Lvotva Sect.BLol.2:211-237.
Schroder, $H$ (1966). The influence of mineral Partillzatian and location on the morphine content and other qualftative and quantitave character of poppy (Bapavor gomifferuin L) (Gara). Pharmazio. 21 (10): 635-641.
5ingh Daljit (1973). Ofallel analyals for combining ability over
 33 (3) 11:469-482.
Singh, U.Prand K.R.Khanna (197a). (ale aterility in opiun poppy (fapayag gomnifarum L). Sci. A Cul. 36:554-556.
Singh, Lep' and K.h.Khanna (1975). Haterasis and coabining ability

Sosa Bowsdenis, C., PeLecat and A.Sosa (1963). Tha inheritance of pigmantation in papavar eomnifarua L. Campt. Fiond.Wabd. Scances Aced.5e1. 25612603-2685.
Tetenyi, Pbo, W.Larincz and K. 5 zabo (1961). Investigation on intraspecific chminical differences in oplum pappy. Characterization of hybride of papavar agoniferum $L \times$ g-orlantale L . (Cer). Pharazie 16(8):426-433.
Ved Kaj Henziken (1970). Experioment with otrains of opium pappy (Papaver aganiftarum b) 1965-1969 (Gar). 5aertryk of Tiasakrift far plan Iaqui. 74:475-4日0.


Von HeBahm (1965). (Garm). Planta nadlca 13:235.
Van H.Bohn (1970). Enylish Sumazy f Planta Madica (Stuttgart) B.d. 19 Hapt. 2:94-109.

Voskeruas, J.(1960). Eng11sh Sumary, Pharmazie. 15:552-556. Watson, D.J.(1958). The dspendence of net assiailabion rate In leap area index. Ânn.-Bot. M5:22:37-54.

Yeaui, K(1937). Cytogenetical atudies in artificially saised intarspecipic hybrids of Papaver VII. Papavar gomniferug $L \times$ Pobractatata Lindl. Cytolagia a) (2): 331-342.

Zaschke, $M$ (1962). The genetic yariability of the alkalaids content of Papavers aonnd farule $L$ (ier). In gemaliat, 36 (314): 185-192.


[^0]:    - Significant at 5 laval
    *"signipicant at $1 \%$ lavel

[^1]:    - 5ignipleant at 5\% levai
    ** Significant at $1 \%$ Laval

[^2]:    - Significant at 5\% level
    *sIgnificant at 15 lavel

[^3]:    * Significant ot fir leyel
    oegignificant at 1,5 ievel

[^4]:    - Significant at 5\% lavel
    ** Significant at $7 \times$ level

[^5]:    * Signifinant at 5/i level
    ** Significant at $1 \%$ Lavel

[^6]:    * Signipieant at 5, Invel
    ensignipieant at 1 / level

[^7]:    * 5ignificant at 5\% laval
    **algnipicant at $1 \%$ leval

[^8]:    - Significant at $9 ; 6$ laval
    en Signipicant at $1 / \%$ laval

