Hkkjrh; df"k vul/kku if=dk] **35**(1 o 2): 1-9 DOI: 10.18805/BKAP206

vkj-,u-,-&l d }kjk NkVh byk;ph ¼*byVfj;k dkMkekee eVu*½ d ek t d jkx e ikni fo"kk.k bVjD'ku r= vkj l ;ä iFk

vkfej [kku[1]] t,ulu t,t d[2]] jkgy flg t ljkfV;k[1]] ;-ch- vxMh[1]] ehj vkflQ bdcky[1]] lkfjdk tk;loky*[1]] vfuy jk;[1] ,o fnu'k dekj[1]

Hkk-—vu-i- & Hkkjrh; —f"k lkf[;dh vul/kku lLFkku] ub fnYyh &110 012] HkkjrA

ikIr% tu 2020 Lohdr% vxLr 2020

lkjk'k

lhfer rVh; m".kdfVc/kh; n'kk e mxkb tku okyh NkVh byk;ph ¼*byVfj;k dkMkekee*½ lcl egxh vkj 0;kid :i l fu;kr dh tku okyh mi tk e l ,d g ft ldk of'od dkjkckj 10 fcfy;u vejhdh Mkyj l Hkh vf/kd gA ektd / ekcy jkx mu çe[k ck/kkvk e l ,d g ft ld fy, vk.kfod Lrj ij jkx dk le>u dh vko';drk gkrh gA u rk bldk i.k thuke vuØe vkj u gh dkb thukfed l lk/ku miyC/k g] ft ld dkj.k vkj,u, ld –f"Vdk.k r t vkj fdQk;rh fodYi gk ldrk gA Mh ukok VklfLØIVke v lcyh byfeuk fg&ld MVk d lkFk fd;k x;k FkkA dy 5317 Mh-b-th-¼vrj 0;ä thu½] 2267 Vh-,Q-¼VklfØI'ku dkjd½] 114 ekx vkj 175952 tfud {k= d lpd ekdj çkIr fd, x, FkA thu fu;ked uVod fo'y"k.k u ekcy jkx e 'kkfey vk.kfod ?kVukvk dk fMfØIV fd;kA ;g igyh VklfØiVkfed fjikV g ft le v,fDlu gkfe;kLVfl l vkj ,fFkyhu flXufyx e xMcMh d dkj.k e/;LFkrk d fy, vx.kh jkx r= dk irk pyrk gA oc&thukfed l lk/ku (SCMVTDb) dfYir vk.kfod ekdj] mEehnokj thu vkj çfrfyfi tkudkjh dk lphc) djrk gA SCMVTDb dk mi;kx NkVh byk;ph mRikndrk d ç;kl e ektd jkx d f[kykQ telykTe l/kkj e fd;k tk ldrk gA

'kCn dqth% NkVh byk;ph] çfry[k] vk.kfod ekdj] thukfed l lk/ku] th-vkj-,uA

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Plant virus interaction mechanisms and joint pathways in mosaic disease of Small Cardamom (*Elettaria cardamomum maton)* by RNA-Sec

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ABSTRACT

Small cardamom (*Elettaria cardamomum*), is one of the costliest spices across the globe. It is grown in limited coastal tropical countries. It is widely exported agri-produce with global turnover of > 10 billion USD. It is majorly affected by the mosaic or marble disease and hence warrants the deep study at molecular level. Till now, there is no availability of whole genome sequence along with any genomic resources. Under such cases, RNA seq approach can be a rapid and economical alternative to gather the information at genomic level. De novo transcriptome assembly was carried out using Illumina Hiseq data. Analysis revealed a total of 5317 differentially expressed genes, 2267 transcription factors, >100 pathways and 175,952 genic region putative markers. Gene regulatory network analysis was performed to see the molecular events playing role in marble disease. We report the first transcriptomic results that shows the disease mechanism mediated by perturbation in auxin homeostasis and ethylene signaling. These events lead to senescence. We also developed the web-genomic resource, SCMVTDb which houses putative molecular markers, candidate genes and transcript information. Such web resource can be used in

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[1] Hkk-—vu-i- & Hkkjrh; —f"k lkf[;dh vul/kku lLFkku] ub fnYyh &110 012] Hkkjr

[2] Hkk-—vu-i- & Hkkjrh; elkyk vul/kku lLFkku] dk>hdkM] djy & 673 012] Hkkjr

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small cardamom germplasm improvement against mosaic disease in endeavour of its increased productivity.

Key words: Small cardamom, Transcript, Molecular marker, Genomic resource, G.R.N.

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14oh 'krkCnh lgh] elky lkekftd&jktuhfrd& vkfFkd vk;ke d of'od 0;kikj e viuh Hkfedk d fy, tku tkr g (Sass]1981½A vkt Hkh] elky lcl egx ¼çfr bdkb otu½ —f"k&telykTe e l ,d g] ftldk of'od ckt kj eY; pkoy vkj xg dh ryuk e 30 xuk vf/kd gA nkuk çdkj dh byk;ph vFkkr NkVh vkj cMh byk;ph e] NkVh byk;ph 0;kid :i l vkgkj vkj vk"k/kh; mí'; d fy, mi;kx fd;k tkrk g ¼Daneshi-Maskooni *et al;* 2017; Devi, 2016½A NkVh ;k gjh byk;ph ¼byVfj;k dkMkekee½ ,d ckjgekl h] tMh&cVh] çdn] ,d&cht i=h ik/kk g tk ftxhcjl h ifjokj l lcf/kr g] ftldh [krh nfu;k d m".kdfVc/kh; {k=k e dh tkrh gA bl ^elkyk dh jkuh^ d :i e Hkh tkuk tkrk g] tk fd ouhyk vkj dlj d ckn fo'o dk rhljk lcl egxk elkyk gA ;|fi ;g elkyk lhfer rVh; m".kdfVc/kh; n'kk tl fd XokVekyk] Hkkjr] Jhydk] rtkfu;k] vy lkYokMkj] fo;ruke] ykvkl] dckfM;k vkj ikivk U; fxuh e mxk;k tkrk g] ijr ;g 0;kid :i l fu;kr dh tku okyh oLr e l ,d g vkj bldk mRiknu vkj eY; fo'o d vf/kdk'k fgLl dk çHkkfor djrk g ¼Biju *et al;* 2010; Reyes *et al;* 2006½A ;g vueku yxk;k x;k g fd oreku of'od dkjkckj ¼10 fcfy;u vejhdh Mkyj½ 2023 vkj 2040 rd Øe'k% 30 vkj 40 fcfy;u vejhdh Mkyj dh of) dju okyk gA ;fn bl cgeY; Qly dh mRiknndrk dk thukfeDl —f'Vdk.k dh lgk;rk }kjk c<k;k tk; rk bldk ykHk of'od mi Hkkäkvk d fy, cgrj eY; gkxkA 'kh"k nk mRiknndk] XokVekyk vkj Hkkjr d chp mRiknndrk vrj ½2-5 xuk½ dh xfr'khyrk n'kkrh g fd db vU; n'kk e Hkh mRiknndrk e of) d fy, vkuof'kd l/kkj dh i;kIr lHkkouk g ¼Reyes *et al;* 2006½A

fofHkUu tfod vkj vtfod rukok mRiknndrk e ck/kk gA vtfod rukok e o"kk vkj enk mojrk çklfxd g ¼Murugan *et al;* 2007½A tfod rukok e] fo"kk.k] thok.k vkj dod vke g ¼Thomas & Bhai, 1995½A ekt d ;k ekcy jkx çe[k tfod rukok e l ,d g tk mRiknndrk dk çfrdy :i l çHkkfor djrh gA ;g byk;ph ekt d fo"kk.k ¼CdMV½ d dkj.k gkrk g tk ikVhfofjMh ifjokj d thul edjkok;jl d vrxr ,d çt kfr gA ;g Hkkjr] Jhydk] XokVekyk vkj db vU; n'kk e çpfyr g ¼Biju *et al.,* 2010½A iÙkh dh ihyh gjh /kkfj;k vkj ml dk fdukjk ,d vyx ekt d :i nrk g vkj çk;% ;g jkx fo"kk.k d leg d dkj.k gkrk g tk fd ml d oDVj }kjk Qyrk g] ftld chp dyk ,fQM ¼iUVykfu;k fuxkujokl k½ lcl vke gA mRiknndrk e Øfed deh ¼70%½ gkrh g vkj rhu o"kk e ;g ijh rjg vuRiknd gk tkrk g ¼Jacob & Usha, 2002½A jkx çfrjk/kh çt kfr;k d fodkl e lhfer lQyrk d dkj.k CdMV ¼lh-Mh-,e-oh-½ dk jkx çc/ku ,d cMh pukrh g ¼Tiwari *et al.,* 2015½] bl çdkj ,l ç;kl k d ijd d fy, odfYid thukfed —f"Vdk.k dh vko';drk gkrh gA rFkkfi bl Qly dk u rk ijk thuke vuØe miyC/k g vkj u gh l/kkj d vkuof'kd vuç;kx dh 'k#vkr d fy, dkb oc&thukfed l lk/ku miyC/k gA gkykfd lhfer Ård fof'k"V VkIfØiVkfed v/;;u ¼F- Nadiya *et al.,* 2017½ fd, x, g] ftle vtfod ruko ¼l[kk½ çfrfØ;k ¼Anjali *et al.,* 2017½ ij doy dN gh fjikV g] yfdu bl Qly e fdlh Hkh tfod ruko çfrfØ;k dh dkb fjikV ugh gA pfd NkVh byk;ph ft ldk thuke ½2-8 Gbp½ ¼Anjali *et al.,* 2016½ cMk g] vHkh rd vuØe fd;k tkuk g] bl çdkj VkIfØlVke vk/kkfjr —f"Vdk.k çt kfr l/kkj d fy, vko';d ,lkfl,'ku v/;;uk d fy, vk.kfod ekdjk dh vko';drk dk ijk dju d fy, ,d ykxr çHkkoh vkj rRdky fodYi gk ldrk gA

oreku dk; dk mí'; ik/kk dh çfrj{kk çfrfØ;k r= dh xgu le> d lkFk&lkFk lØe.k çfØ;k dk Li"V dju d fy, ikni fo"kk.k d lid d vk.kfod r= dh tkp djuk g tk jkxtuu dk lxe cukrk gA bldk mí'; NkVh byk;ph d ekt d jkx e lc) iFkk d fu;=.k e 'kkfey thu fofu;ked uVod d fuek.k }kjk çe[k mEehnokj thuk dh igpku djuk gA bldk mí'; Hkfo"; d ,lkfl,'ku v/;;u d fy, oc thukfed l lk/ku fodflr dju d fy, çe[k mEehnokj thuk l dfYir vk.kfod ekdjk ¼,l-,l-vkj-] ,l-,u-ih- vkj buMYl½ d [kuu dk Hkh gA

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thukfed l lk/ku SCMVTDb dh miyC/krk% http%//webtom-cabgrid-res-in/scmvtdb/

lkexh ,oa ijh{k.k fof/k

lxg.k] ,fQM d,yuh dk j[kj[kko vkj Vhdkdj.k% çkjHk e ,fQMl ¼iVkykfu;k dykMh½ d vkifuof'kd :i }kjk [kr dh ifjfLFkfr;k e byk;ph d ik/kk dk mifuo'k.k fd;k x;k FkkA fo'kkä ç—fr dk ckgj fudkyu d fy, vkj 'k) d,yuh çkIr dju d fy,] 0;fäxr eknkvk dk vyx l dhi d :i e cukb xb byk;ph ¼fdLe% vlikxyk 1½ dh ;ok LoLFk ifÙk;k ¼4&5½ ij LFkkukrfjr fd;k x;k FkkA rRi'pkr] dhi dk ikuh e Mc fupy Nkj d lkFk v/kj e j[kk x;k rkfd 'k"drk dk jkdk tk ldA eknk ,fQMl u vfu"kd :i l çtuu fd;kA lpj.k v/;;u d fy, i;kIr vkckn h d fuek.k rd dkykfu;k dk le;≤ ij ub byk;ph d iÙkk dh dhi e LFkkukrfjr fd;k x;k FkkA lhMh-,e-oh- ¼CdMV½ d vlikxyk LVu dk bLreky fd;k x;k Fkk] ftl vkblh,vkj&vkbvkb,lvkj ¼ICAR&IISR½] dkyhdV] djy] Hkkjr e ¼11-2588°N, 75-7804°½ NkVh byk;ph dh vlikxyk 1 fdLe ij cuk, j[kk x;k FkkA ok;jy lpj.k pkFk ;k ikpo bLVkj mnklhu ,fQMl }kjk fd;k x;k FkkA

vkj-,u-,- vyxko] lh-Mh-,u-,- l'y"k.k] ykbcjh fuek.k vkj vuØe.k% nkuk ik/kk fu;f=r vkj fo"kk.k lØfer ik/kk dh iÙkh Ård d ueu ,d= fd, x, FkA vkj,u, vyxko d fy, ueuk Hkj e ifjoru'khyrk dk de dju d fy, nl tfod çfr—fr ueuk dk tek fd;k x;k FkkA byk;ph d Ård dk e i,yhQuky vkj i,yhldjkbM lkexh gkrh g tk vkj,u, d fu"d"k.k dk xHkhj :i l çHkkfor djr g] bl çdkj geu çdkf'kr NkVh byk;ph fof'k"V vkj,u, fu"d"k.k çkVkd,y dk mi;kx fd;k g ftle vkj-,u-bth lykV feuh fdV ¼Qiagen½ vkj lhVh,ch ¼lhVkby VkbeFkkbyvekfu;e ckekbM½ dk l;ktu ¼Fasiludeen Nadiya *et al.,* 2015½ e of.kr x.koÙkk vkj ek=k dh tkp d lkFk&lkFk gA vkj,u,&ld ykbcjh dk r;kj fd;k x;k Fkk vkj 101 U;fDy;kVkbM ;fXer vr jhMl d lkFk byfeuk gkbld 2000 ¼Illumina HiSeq™ 2000½ ep fuekrk d çkVkd,y dk mi;kx djd vuØe.k fd;k x;k FkkA

iwa çlLdj.k vkj Mh ukok vuØe.k% NkVh byk;ph d fu;f=r vkj fo"kk.k lØfer ik/kk dk ;fXer vr vuØe.k MVk 2*101 chih d lkFk byfeuk gkbld rduhd dk mi;kx djd mRiUu fd;k x;k FkkA vudyd vuØe ¼,MkIVl lhDol½ dk gVkuk] vf/kd çfrfuf/kRo fd; x; vuØe ¼vkojjfçVM lhDol½] de x.koÙkk oky jhMl] 5^ vkj 3^ l cl dk fVe djuk vkj ÝM&Ldkj ≤20 fVekefVd Vy ¼Bolger *et al.,* 2014½ dk mi;kx djd fd;k x;kA bld vykok] fVfuVh dkMkrjd ¼vlEcyj½ v2-0-6 ¼Haas *et al.,* 2013½ dk mi;kx djr g, Mh ukok VklfØl'kuy vuØe.k ¼vlcyh½ d fy, nkuk ueuk dh mPp x.koÙkk oky jhMl dk mi;kx fd;k x;kA

vUrj 0;ä thu dh igpku% ckmVh Vy dk mi;kx fu;f=r vkj fo"kk.k lØfer jhMl dh çfrfp=.k d fy, NkVh byk;ph d Mh ukok vuØe.k ij fd;k x;k FkkA vfHk0;fä dh x.kuk d fy, ,DliDV'ku&efDlekbt'ku ¼RSEM½ midj.k }kjk vkj,u,&ld dk mi;kx fd;k x;k Fkk ¼B- Li & Dewey, 2011½A vkj ck;kdMDVj d ,tvkj ¼fMftVy thu ,Dlç'ku bu vkj½ Vy dk mi;kx çkpy tl ,QMhvkj 0-05 vkj y,x 2 QkYM ifjoru eku 2 d :i e fu;f=r vkj fo"kk.k lØfer ueuk e vrj 0;ä thu dh ryuk dh igpku d fy, fd;k x;k Fkk ¼Robinson *et al.,* 2009½A

vuq:irk [kkt] ,ukV'ku vkj dk;kRed y{k.k o.ku% vrj 0;ä thuk dh vu:irk [kkt d lkFk&lkFk Mh ukok VkfLØlVke vuØe.k u'kuy lVj Q,j ck;kVDuky,th bUQ,e'ku ¼,u-lh-ch-vkb-½ ¼NCBI½ xj&fujFkd MVkcl ¼ftp%//ftp-ncbi-nlm-nih-gov/blast/db/½ d fo#) çn'ku fd;k x;k Fkk] ftld fy, CykLV ,YxkfjFe] LVMvyku ykdy ,u-lh-ch-vkb&CykLV&2-2-31 dk mi;kx Fk'kkYM b&eku 1e-3 d lkFk fd;k x;kA rRi'pkr dk;kRed oxhdj.k] thu v,UVky,th] d-b-th-th- ¼KEGG½ ¼D;kVk ,ulkbDykihfM;k v,Q thu ,M thuke½ iFk fo'y"k.k] ,tkbe oxk] Mkeu vkj ifjokjk dk Cy,LV 2xk çk lLdj.k 3-1 l,¶Vo;j dk mi;kx djd [kktk x;k ¼Conesa *et al.,* 2005½A lykV Vh-,Q-Mh-ch 4-0 dk mi;kx VklfØl'kuy dkjdk dh igpku d fy, fd;k x;k Fkk ¼J-Jin *et al.,* 2016½A

tfud {k= dk dfYir vk.kfod ekdjk dk [kuu% dkfMx {k= d dfYir Mh,u, ekdjk] vFkkr ljy vuØe fjihVl g ¼,l,lvkj½ ekdjk] ,l,uih vkj buMYl dk ,e-vkb-,l-,&ekbØk lVykbV vkbMfVfQd'ku Vy ¼Thiel *et al.,* 2003½ dh iy Hkk"kk dk mi;kx djr g, Mh ukok VklfØlVke vuØe.k l [kuu fd;k x;k FkkA ,l,lvkj ekdj fo'y"k.k d fy,] ekukU;fDy;kVkbMl d fy, nl fjihVl] MkbU;fDy;kVkbMl d fy, Ng fjihVl vkj VkbU;fDy;kVkbMl] VVkU;fDy;kVkbMl] iVkU;fDy;kVkbMl vkj gDlkU;fDy;kVkbMl d fy, ikp fjihVl fy, x,A çkbej dk çkbej 3dkj ,DthD;Vcy ¼Untergasser *et al.,* 2012½ dk mi;kx djd ,l,lvkj yklkb d ik'o ¼¶yfdx½ {k=k e fMtkbu fd;k x;k FkkA ofj,V d,fyx d fy,] fo"kk.k l lØfer jhMl dk cjkl&0ghyj ,ykbuj

¼chMCY;½ Vy ¼H-Li & Durbin, 2009½ dk mi;kx djrs g, Mh ukok VklfØlVke vuØe.k e ekufp= fd;k x;k FkkA ,l ,u ih ¼flxy U;fDy;kVkbM i,yhekfQTe½ vkj buMYl ¼lfEeyu vkj foykiu½ dk d,y dju d fy, ,l-,-,e- Vy (SAMtools½ ¼H-Li, 2011½ idt dk mi;kx fd;k x;k FkkA egRoi.k ,l ,u ih vkj buMYl dh igpku dju d fy, fQYVfjx ekinM] vFkkr jhMl dh xgurk ≥ 4] x.koÙkk Ldkj ≥ 20 vkj nkuk rjQ ik'o ¼¶yfdx½ {k= 50 mi;kx fd, x, FkA

thu fofu;ked ¼jxxyVjh½ uVod dk fuek.k% lkbVkLdi 3-2-1 dk mi;kx djd thu fofu;ked uVod fo'y"k.k fd;k x;k Fkk (Shannon, 2003½A vfHk0;fä lglc/k lyxbu ¼http%//apps-cytoscape-org/apps/expressioncorrelation½ vkj uVod fo'y"k.k dk;Øe dk mi;kx uVod d fuek.k d fy, fd;k x;k FkkA uVod fo'y"k.k d fy, vR;f/kd fofu;fer ¼vixM½ vkj de fofu;fer ¼MkmuxM½ thu fy, x, FkA tfVy uVod cuk;k x;k Fkk vkj gc thuk dk fMxh vkj chp&chp dh dæh;rk tl ekinMk d vk/kkj ij p;fur fd;k x;k FkkA

ifj.kke ,oa foospuk

vuØe MVk dk io&çlLdj.k vkj l;kt% fu;f=r vkj lØfer ueuk dh Øe'k% dy 18403660 vkj 17739633 ;fXer vr jhMl mRiUu gbA 30988 ¼fu;f=r½ vkj 30945 ¼lØfer½ de x.koÙkk oky jhMl dk gVku d ckn] 'k"k jhMl dk mi;kx MkmuLVhe fo'y"k.k ¼rkfydk 1½ d fy, fd;k x;k FkkA fVfuVh }kjk th-lh- x.kuk 43-14% vkj 1520 chih ¼bp½ d ,u50 eku d lkFk dy 123338 çfrfyfi mRiUu fd, x, FkA ldfyr çfrfyfi dh U;ure vkj vf/kdre yckb Øe'k% 201 vkj 9327 chih FkhA çfrfyfi dh vf/kdre l[;k 200 l 299 chih dh yckb dh lhek e ikb xb ¼34020 çfrfyfi½] bld ckn Øe'k% 16576 vkj 10104 çfrfyfi e yckb 300 l 399 vkj 400 l 10104 d chp ikb xbA

vrj 0;Dr thu dh cgrk;r ipjrk dk vkdyu vkj igpku% ,Qihd,e d :i e vfHk0;ä eku dh x.kuk dju d fy, fu;f=r vkj fo"kk.k lØfer nkuk ueuk d ;fXer vr jhMl e Mh ukok VkfLØlVke vuØe.k e ekufp=.k fd;k x;k FkkA bu vfHk0;ä ekuk dk mi;kx vrj 0;ä thu dh igpku d fy, fd;k tk ldrk gA oreku v/;;u e] vrj 0;ä thuk dh igpku ,u-vk-vkb ld ¼NOISeq½ vkj ,tvkj rjhdk l dh xb FkhA ,u-vk-vkb ld dk mi;kx djrs g, q eku ¾ 0-95 ij dy 3519 Mhb th çkIr fd, x, FkA ,tvkj Vy l dy 5317 Mhb th ¼2579 vi vkj 2738 Mkmu jxyVM½ dh [kkt dh xbA nkuk fof/k;k }kjk vke Mhb th dh çfr'kr lekurk 98-41% Fkh tk fd ,tvkj }kjk fu"d"kk dh fo'oluh;rk dk n'kkrh gA ,tvkj }kjk çkIr fu"d"k dk vkx d fo'y"k.k d fy, mi;kx fd;k x;kA

vuqla/kku [kkt] ,ukV'ku ¼mYy[k½ vkj dk;kRed y{k.k o.ku% 5317 çfrfyfi;k e l] geu ik;k fd 4913 çfrfyfi xj&fujFkd MVkcl e ekt n vU; thuk d lkFk lekurk j[ku okyh çkIr gb] tcfd 404 çfrfyfi fcuk fdlh lekurk d] uohu çrhr gbA dy 1243 çfrfyfi ekufp=.k e vkj 2947 çfrfyfi th-vk-¼GO½ ,ukV'ku çfØ;k e lfEefyr FkA 'kh"k fgV çtkfr;k d forj.k u elk ,D;feukVk ¼3328½ d lkFk vf/kdre fgV dk irk yxk;] bld ckn byk;l xbuhufll ¼2014½ vkj Qk,fuDl MDVkbfyQjk ¼141½ çfrfyfiA ljf{kr olh; vEy ¼QVh ,flM½ to l'yf"kd iFkk d dkj.k bu ,dchti=h ik/kk d lkFk vf/kdre lekurk ik;h xbA CykLV 2 thvk ,ukV'ku ifj.kke ku bu vrj 0;ä thuk dk rhu mi Jf.k;k tl tfod çfØ;k] vk.kfod dk;k vkj dk'kh; ?kVdk e oxh—r fd;kA NkVh byk;ph d Mh ukok VkfLØlVke vuØe.k dk CykLV fo'y"k.k xj&fujFkd ¼,uvkj½ MVkcl d f[kykQ fd;k x;k Fkk ftle irk pyk Fkk fd 123338 çfrfyfi;k e l 81966 ¼66-5%½ ,uvkj MVkcl e Kkr thu d lkFk lekurk fn[kkr gA vf/kdre çfrfyfi;k e elk ,D;feukVk] byk;l xbuhufll] Qk,fuDl MDVkbfyQjk vkj okbfVl fouhQjk d lkFk Øe'k% 51955] 3588] 2808 vkj 682 d lkFk lekurk fn[kkb ¼ifjf'k"V 2½A

ikni çfrj{kk çfrfØ;k e 'kkfey mEehnokj thuk dh [kkt% ; Mhb th çe[k mEehnokj thuk vkj iFkk dk

rkfydk 1% NkVh byk;ph ¼byVfj;k dkMkekee½ d fu;=.k vkj fo"kk.k lØfer ueuk dk fVfex fooj.kA

	fufo"V ;fXer jhMl	nkuk cp	doy vkx oky cp	doy ihN oky cp	ifrr
fu;f=r	18403660	17887330 (97–19%)	445919 (2–42%)	39423 (0–21%)	30988 (0–17%)
fo"kk.k lØfer	17739633	17142028 (96–63%)	530469(2–99%)	36191 (0–20%)	30945 (0–17%)

çfrfuf/kRo djr g tk ikni fo"kk.k bVjD'ku e tM gkr gA bl oreku v/;;u e] egRoi.k çe[k vrj 0;ä thuk tl jkx çfrjk/kd vkjth,1 ¼RGA1½ vkj vkjth,3 ¼RGA3½] ekbVk tu&,fDVoVM dkbut ,,uih ¼ANP1½&ykbd] jkxtuu lc/kh çkVhu 1 ¼PR1½] FkkmefVu&ykbd çkVhu ¼PR5½] ,u,lh çfrfyfi dkjd] ,yvkjvkj fjlIVj&ykbd ljhu Fkvkfuu&dkbul] ,uch,l&,yvkjvkj jkx çfrjk/kd] XyVkfFk;ku ,l&VklQjt] ghV 'k,d d,XuV 70 dMh, ik;k x;kA

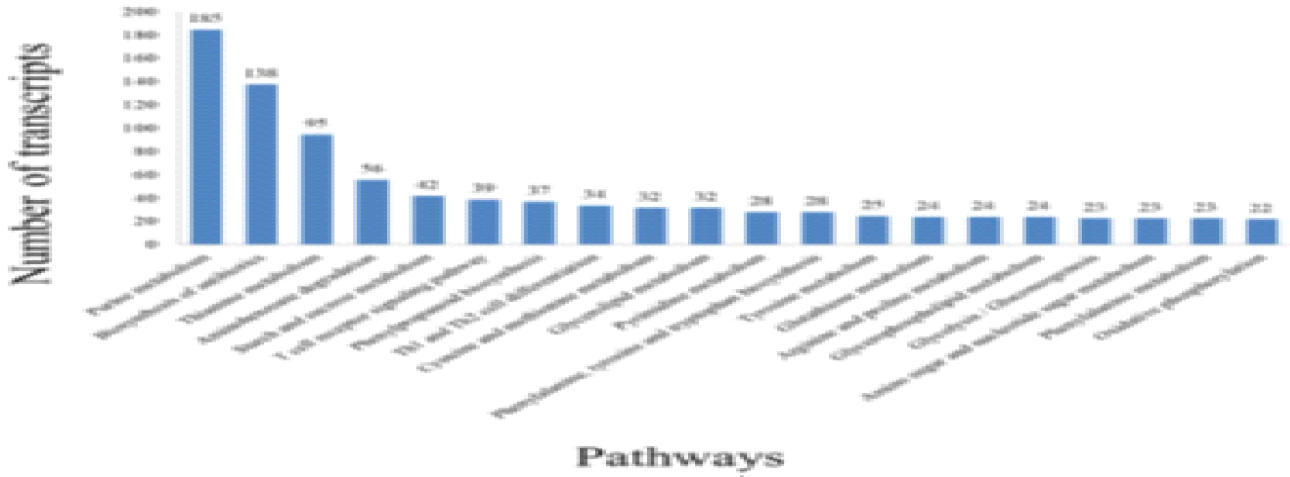
db vU; thu tk jkx çfrjk/kh Qlyk d fodkl d fy, ektd jkx d f[kykQ egRoi.k gk ldr g vrj 0;ä fo'y"k.k l igpku x,A mnkgj.k d fy,] ihvkj ¼PR1½ thu ftUg fofHkUu jkxtudk d fo#) ikni j{kk e çfrj{kk ç.kkyh çfrfØ;k e ,d egRoi.k Hkfedk fuHkku d fy, tkuk tkrk g] tl fo"kk.k tfur] QQnh; vkj thok.k tfur; ihvkj5 ¼PR5½A VekVj e çfrofnr ihvkj1 ¼PR1½ thu u vifofu;eu fn[kk;k tc ik/k ikVVk iiy V,i QkbVklykTek l lØfer gk tkr gA

fo"kk.k tfur jkxtuu e 'kkfey iFkk dh [kkt% dbthth ¼D;kVk ,ulkbDykihfM;k v,Q thu ,M thuke½ iFk fo'y"k.k dju ij 114 iFkk e dy 1638 çfrfyfi çkIr g, FkA vf/kdre çfry[k ¼185½ l;fju mikip; e 'kkfey ik, x,] bld ckn ,Vhck;kfVd nokvk vkj Fkk;feu mikip; d tol'y"k.k e Øe'k% 138 vkj 95 çfrfyfi çkIr g, ¼fp= 1½A vf/kdre çfrfyfi;k çkVhu ifjokjk tl lkbVkØke ih450 ¼IPR001128½] lkbVkØke ih450] b&Dykl] xi I (IPR002401½] çkVhu Q,LQVt 2lh ifjokj ¼IPR015015655½] y?k&J[kyk fMgkbMktut @ fjMDVl ,lMhvkj ¼IPR002347½ vkj dhV NYyh eFkA ¼IPR000618) e Øe'k% 30] 22] 20] 17 vkj 16 çfrfyfi;k mifLFkr FkhA

ik/kk dh çfrj{kk çfrfØ;k e 'kkfey çfry[ku dkjdk dh Hkfo";ok.kh% VklfØl'kuy dkjdk dk CykLV&,Dl Vy dk mi;kx djd lykV Vh,QMhch 4-0 d fo#) [kktk x;k FkkA b&eku] 1e&05 d lkFk 5317 çfrfyfi;k e l dy 2267 VklfØl'kuy dkjd n[k x,A gekj fo'y"k.k e] cfld gfyDl&yi&gfyDl ¼bHLH½] ek;ykCykLVkfll lcf/kr çkVhu ¼MYB½ vkj ,u,lh [{N¾ NAM ¼uk ,fidy efjLVe½À] ¿A=ATAF ¼,jfcMkflll VkfLØl'ku ,fDVo'ku QDVj½À] ¿C=CUC ¼di&'kIM d,fVyM,u½À] VklfØl'kuy dkjdk dk vf/kdre Øe'k% 251] 233 vkj 154 ckj ik;k x;kA jkxtud vkØe.k d nkjku tfod] vtfod ruko vkj flXuy ikjxeu ¼VklMD'ku½ d fo#) ik/kk d j{kk r= e VklfØl'kuy dkjd egRoi.k Hkfedk fuHkkr g ¼Alves *et al.*, 2014½A lykV Vh,QMhch 4-0 ¼lykV VklfØl'kuy QDVj MVkcl½ d f[kykQ gekj CykLV ifj.kke] geu bu ch,p,y,p] ,eokbch] ,u,lh] lh2,p2] MCY;vkjdokb VklfØl'kuy dkjdk d lkFk vf/kdre çfrfyfi fgVl çkIr g,A

,eokbch fodkl vkj tfod rFkk vtfod ruko dh çfrfØ;kvk e Hkfedk fuHkkrk g] vkj Mh,u, d lkFk ck/ku dh {kerk j[krk gA geu mPp vifofu;eu d lkFk viu v/;;u e db ,eokbch le:i ¼vkblkQ,el½ ik, tk jkx çfrjk/kh Qly d fodkl d fy, mi;kx fd, tk ldr g ¼Alves *et al.*, 2014½A lh2,p2 j{kk çfrfØ;k vkj fofHkUu 'kkjhfjd çfØ;kvk e egRoi.k Hkfedk fuHkkrk g ¼Jiang & Pan] 2012½A geu viu v/;;u e db ch,p,y,p] Vh,Q dk vifofu;eu d lkFk ik;k] ftudk mi;kx çfrjk/kh Qlyk dk fodflr dju d fy, fd;k tk ldrk gA

dfYir vk.kfod ekdjk dk [kuu% dy 5317 vkj 21735 dfYir ,l,lvkj ekdjk dk Øe'k% vrj 0;ä



fp= 1% NkVh byk;ph ¼byVfj;k dkMkekee½ d vrj 0;ä thu d 'kh"k 20 dbthth ¼D;kVk ,ulkbDykihfM;k v,Q thu ,M thuke½ iFkA

rkfydk 2% ljy vkj fefJr dfYir ekdjk d :i e çkIr dfYir ekdjk çkIr fd, x, dh foLrr tkudkjhA

	vrj 0;ä thu	Mh ukok VkfLØlVke vuØe.k
vuØe dh tkp	5317	123339
igpku x, ,l,lvkj	1445	21735
vuØe ;ä ,l,lvkj	1189	18411
1 l vf/kd ,l,lvkj oky vuØe	206	2827
fefJr :i e mifLFkr ,l,lvkj	66	916
ekuk U;fDy;kVkbM	834	12497
Mkb U;fDy;kVkbM	263	3934
Vkb U;fDy;kVkbM	324	4990
VVk& U;fDy;kVkbM	13	228
iVk& U;fDy;kVkbM	6	40
gDlk& U;fDy;kVkbM	5	46

thu vkj Mh ukok VkfLØlVke vuØe.k l [kuu fd;k x;k Fkk] ftldfy, 1092 vkj 15168 çkbejk dh x.kuk çkbej 3 Vy ¼rkfydk 2½ dk mi;kx djd dh xb FkhA geu 21735 ,l,lvkj ekdj ik, tk fofo/krkvk vkj vkuokf'kd fofo/krk v/;;uk e mi;kxh gk ldr gA bl Qly e vc rd <450 ,l,lvkj ekdjk dh lpuk g ¼Anjali *et al.,* 2015½A ij thuke dh vHkko e] mi;kx dju dfy, r;kj ;,l,lvkj ekdj thukVkbfix dh vko';drk dk ijk dj ldr g ¼Huang *et al.,* 2016½A bld vykok ;igpku x, ekdj cg:irk vkj viu ox l fHkUu ox ¼Ø,l VDlku½ dh çtkfr;k d v/;;u dfy, mi;kxh gk ldr gA

jkpd ckr ;g g fd gekj ç;kx e mi;kx fd, tku oky ,d thukVkbi e Hkh fHkUu [kuu ifj.kkek u dy 154217 ofj,V ¼fo"kk.k lØfer ueuk l 149097 ,l,uih vkj 5120 bMYl½ fn[kk;kA ;g fofHkUu le:i ¼vkblkQ,el½ d dkj.k gk ldrk gA vkx bldh if'V ikni çfrj{kk çfrfØ;k'khy thu e ,l,uih d mPp cgrk;r çpjrk l dh xb FkhA

ikni&fo"kk.k bVjD'ku vkj thu fu;ked uVod dk r:=% thvkj,u dk ikni&fo"kk.k bVjD'ku edfuTe d fuek.k d fy, 'kh"k 100 vi vkj Mkmu fofu;fer thu dk p;u fd;k x;k FkkA bl rjg d –f'Vdk.k dæh;rk vkj fMxh ¼104 l 199½ d ekinMk dk mi;kx dj çe[k mEehnokj thu çkIr dju d fy, Mhbth dh l[;k dk de dj nrk gA ;g vkx uVod ekM e çe[k Hkfedk fuHkku oky gc thu dk n'kkrk gA 'kh"k 20 gc thuk e l ¼fMxh eku > 195½] 8 vkj 12 Øe'kh vi vkj Mkmu fofu;fer ik, x,A

ruko dh lonu'khyrk vkj ckn e lh-Mh-,e-oh- ¼CdMV½ d f[kykQ etcku dh çfrj{kk çfrfØ;k gekj fu"d"k [kkt e n[kh xb FkhA vrj 0;ä thu fjllVj&ykbd dkbut ¼RLK½ thu&ifjokj ik;kx;k tk dkf'kdk fHkfÙk d fofu;eu e Hkfedk fuHkk ikr gA vkj;d e ektn Y;lhu&fjp fjihV ,yvkjvkj Mkeu vU; çkVhu d lkFk lpuk dk vknku çnku djrk g ftll jkxtud ekU;rk dh çfrfØ;k dk ldr feyrk gA ;g l;= j{kk r= dk lfØ; djrk g vkj jkx d fo#) çfrjk/k çnku djrk gA vifofu;fer ekbVktu&,fDVoVM çkVhu dkbut dkbut ¼MAPKKK) ,,uih1 ¼ANP1½ tl thu tUetkr çfrj{kk] dk'kh; çfØ;kvk] dkf'kdk&iêV fuek.k vkj dkf'kdk pØ dh çxfr vkj fodkl tl fofHkUu dk;k d fy, tkuk tkrk g ¼H- Jin *et al.,* 2002½A

ikni fo"kk.k bVjD'ku e ;chD;fVu&çkVhtke iFk çkVhu d iru ldr d lkFk lekIr gkrk g] ftld ckn vfr{k; ¼uØkfll½ vkj th.krk gkrk gA fo"kk.k l çfjr ik/k dh vkjvk,l j{kk r= ok;jy çkVhu }kjk mPp ok;jy çfr—fr d fy, mPph—r gk tkrh gA ;vr dh ?kVuk, gekj MVklVe n[kh tkrh gA ,u,yih ¼uØkfll& vkj ,fFkyhu&çfjr çkVhu 1 tl çkVhu½ dkf'kdkfo"kh ¼lkbVkV,fDld½ xfrfof/k d lkFk&lkFk jkxtud d fo"kyiu dh e/;LFkrk djrk g vkj rEckd e fjikV fd, x, ekbØkfc;y d tokc e vkjvk,l ¿çfrfØ;k'khy v,Dlhtu çtkfr;k ¼fj,fDVo v,Dlhtu Lih'kht½À d mRiknu l dkf'kdk dh eR; gk ldrh gA ikni l{ethok e] ;chD;fVu çkVhu d iru dh xfr'khyrk e Hkfedk fuHkkrk gA vifofu;fer ,Q&c,Dl thu ,l çkVhu d iru d fy, vko';d ;chD;fVu'ku dk rt djr gA ok;jy lØe.k d nkjku] gc thu] bvkb,u 3 }kjk ,fFkyhu ldru ¼flXufyx½ iFk d ijd }kjk dkf'kdk of) vkj th.krk dk fu;f=r fd;k tkrk gA

gekj fu"d"kk dk mi;kx jkx l fuiVu dh j.kuhfr d fy, Hkfo"; d fy, vko';d ,xkdfedy fMtkbfux vkj fodkl d fy, fd;k tk ldrk gA vkjth, ¼jftLVl thu ,uky,Xl½ thuk d ifjokj dh igpku thuke okbM ,lkfl,'ku v/;;uk }kjk dh xbg vkj o ikni jkx çfrjk/k d lkFk tMg, dfYir D;Vh,y ¼DokfVVfVo VV ykIkb½ gA rEckd tlh Qly e] ekd fo"kk.k l gku oky lØe.k e ,l thu vrj0;ä gkr gA bu thuke çkVhu&ykbd&fjlIVj] U;fDy;kVkbM ckbfMx lkbV] Y;lhu&fjp&fjihV vkj dkbut&ykbd&fjlIVj] jkxtud çfrjk/k dh e/;LFkrk dju oky Mkeu vkj ekfV¶l dk lj{k.k fd;k x;k gA ; vkjth, çfrfyfi jkx çfrjk/k ¼vkj½ d fy, mEehnokj thu gA

fu"d"kZ

;g vkj,u,&ld –f"Vdk.k }kjk ikni fo"kk.k bVjD'ku r= vkj NkVh byk;ph e ekd jkx dh e/;LFkrk e lfEefyr lc) iFkk ij vk/kfjr igyh fjikV gA geu çe[k mEehnokj thu dh fjikV d lkFk çfry[ku dkjdk }kjk thvkj,u of.kr gc thu vkj bld fu;=.k dk fp=.k fd;k gA v/;;u e v,fDlu gkekLVfll e xMcMh }kjk fodkl gkfu d r= dk irk pyrk g ftll fu;f=r thuk d uVod d ek/;e l ekjcfyx r= vkj th.krk ,fFkyhu ldru }kjk gkrh gA pfd u rk ij thuke vuØe vkj u gh fdlh Hkh thukfed llk/ku bl elky çtkfr;k d fy, miyC/k g] bl çdkj oreku [kkt dfYir ekdjk dh rRdky vko';drk dk ijk dj ldrh gA fo'k"k :i l bl çe[k ok;jy tfod ck/kk d f[kykQ NkVh byk;ph mRikndrk e l/kkj d fy, ,l llk/kuk dh vko';drk gkrh gA

lanHkZ

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